metals and alloys

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HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Charcoal Pig Iron for Fine Grained Iron

Osann (page MA 222 R 9) prefers to make fine grained cast iron by control of the C-Si ratio rather than by superheating. His explanation of the mechanism of the difficulties arising from superheating reminds one of the "House that Jack Built." His final conclusion is a simple one,—use charcoal pig.—H.W.G.

Acid Open Hearth

A complete exposition of the reactions taking place in this process is given by Bardenheuer (page MA 223 L 1). Losses of alloys, action of nitrogen, and slag-metal reactions and their importance are discussed in detail.—C.H.H.

Books Favorably Appraised

Books on Seamless Tubes, Roll Pass Design, Alloys of Fe and Cu, and Stainless Steels, all strike the reviewers favorably (pages MA 224 R 4, MA 225 L 6, MA 248 R 2 and MA 248 R 4). Another useful summary is that of the A.S.T.M. on Service Characteristics of Light Metals and Alloys (page MA 246 L 6).—H.W.G.

Data on Quenching Medium Steel

There has been speculation regarding what takes place at the interface, quenching medium steel, but some real experimental information, obtained by an ingenious technique, is reported by Zavarine (page MA 227 L 10).—O.E.H.

Precautions Necessary in Welding Chromium Steels and Irons

In this article Mr. Hodge (page MA 232 R 4) has pointed out the necessity for preheating air-hardening steels and to maintain the preheating throughout the welding operation. Also need for annealing of air-hardening steels so as to produce uniform hardness. He also points out the care that should be exercised in welding chrome-iron alloys that are subject to bending stresses.—C.A.McC.

What! Relativity Again?

No, not Einstein this time, but the A.S.T.M. reporting (page MA 240 R 5) that the tension test is useful in inspection and design, and as a basis in fabrication and specifications, but in all cases should be used in relation with chemical analysis, grain size, gage uniformity, and surface finish.—W.A.T.

New Process Converts Waste Ferrous Sulphate into Sulphuric Acid

The disposal of the large quantities of "spent acid" used in the pickling department has long been a nuisance in most steel plants. Lately, with the tightening of regulations relating to natural resources such as those covering stream pollution, this has become a serious problem. The development of a successful process (page MA 235 L 3) for utilizing these wastes within the plant itself by conversion into sulphuric acid, to be used again for pickling, is indeed a boon to the industry.—H.S.R.

Does a Kink in the Bend-Tension, Elongation Curve Denote Endurance Limit?

The abstract (page MA 239 L 9) correctly reports the conclusion drawn by Buschmann that a kink in the bend-tension, elongation curve denotes the endurance limit. In general these kinks occur at 5 to 10 per cent elongation. It doesn't make sense that the endurance limit, at which failure occurs without measurable deformation, should correlate with the stress for so large an extension. A glance at the curves in the original article will lead those who have had experience with alleged short cut fatigue tests to take Buschmann's conclusion with a grain of salt and wait for more extensive work and further confirmation before accepting it.—H.W.G.

Souses and 7 Per Cent Cr Steel

Sekiguchi (page MA 251 L 8) has made a study of soy-bean souse. We are not sure what a souse is in that connection, though the word evidently doesn't have its usual meaning. Anyway a 7 per cent Cr steel is resistant to it, whatever it is.—H.W.G.

British Extensive Cooperative Exposure Tests

Extensive cooperative exposure tests for evaluation of corrosion resistance are reported by the British Institution of Civil Engineers and the American Society for Testing Materials (page MA 251 L 3). These long-duration tests are of first importance.—H.W.G.

Protecting the Protective Coating

The last few years have seen considerable progress in pipe coatings. It is now recognized that coatings should be reinforced or shielded. Organic coatings, unless they are themselves protected, are constitutionally subject to deterioration. So now we protect the protective coatings. See the last report on the A. P. I. pipe-coatings tests by Gordon N. Scott (page MA 252 L 2).—V.V.K.

Gold the Standard Again

Back on the gold standard, but nothing so reassuring as sound currency. This relates to electrical resistance standards where 98 Au 2 Cr does not alter in resistance with temperature. Thank heaven, such facts stay put in spite of legislation (page MA 246 L 7).—H.W.G.

Shrinkage Strains in Welds

Mr. Jensen (page MA 232 R 6) has called attention to 10 rules developed to control and reduce stresses which are applicable to welding. These are important and, if followed, will undoubtedly prevent stressed conditions in welds.—C. A. McC.

Anodic Treatment for Pickling High-Speed Steel

Better pickling of high-speed steel is obtained by anodic treatment in caustic soda plus sodium citrate followed by a dip in HCl than by HCl alone, according to Rogers (page MA 235 L 2).—H.W.G.

Electrodeposition of Aluminum from Non-Aqueous Solutions

The inability to use aluminum for electroplating purposes has long been recognized as one of the outstanding drawbacks in the use of this metal. However, with the improvement of methods for depositing aluminum from non-aqueous solutions, definite progress has been made and the use of aluminum plating, at least on a limited scale, now begins to appear as a possibility. (page MA 236 L 7).—H.S.R.

Corrosion by Dairy Products

The resistance of a number of metals to various milk products is given by Mohr, Kramer and Schröter (page MA 252 L 5).—V.V.K.

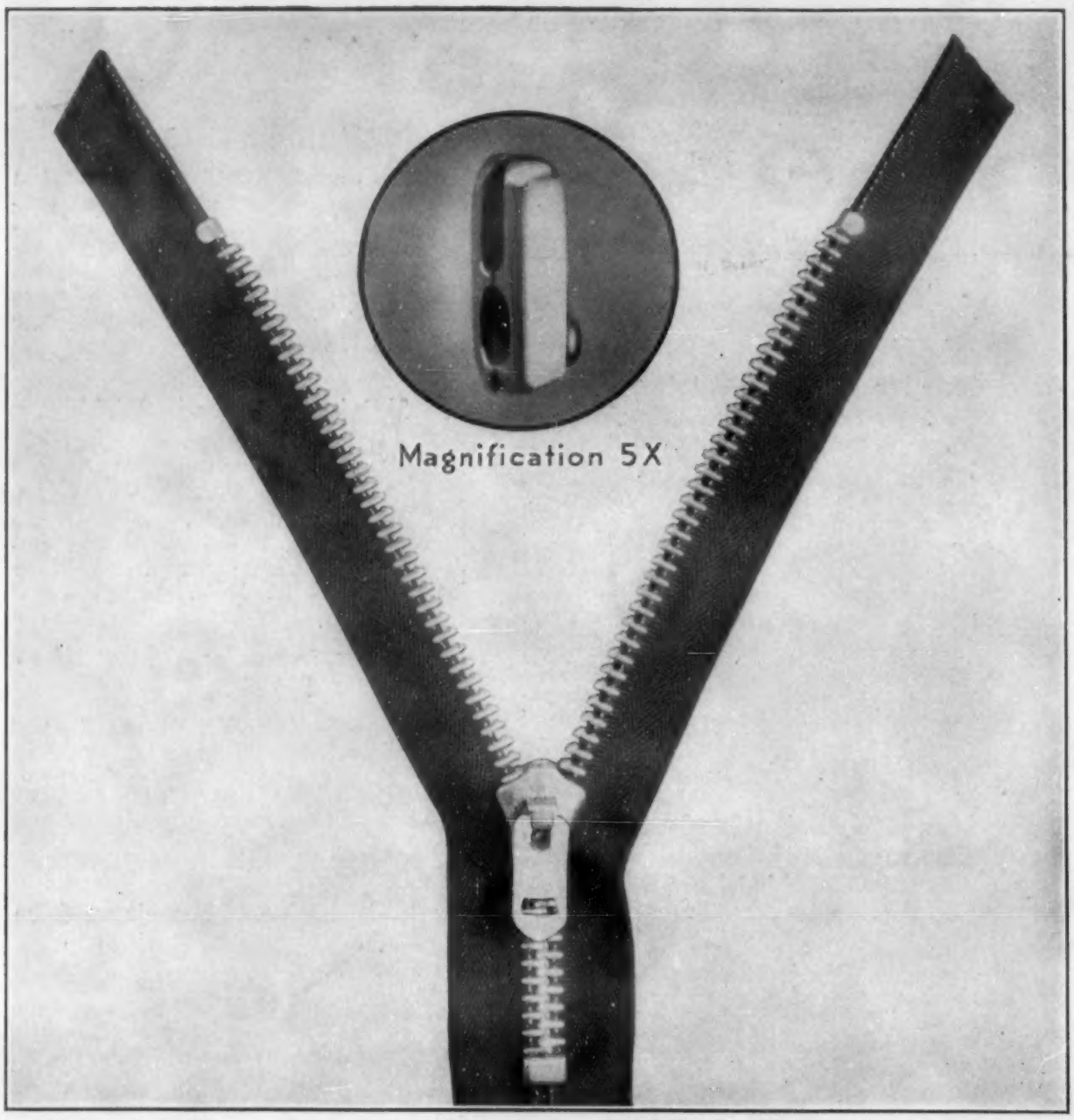
Zinc Base Instead of Steel or Brass for Nickel Plating

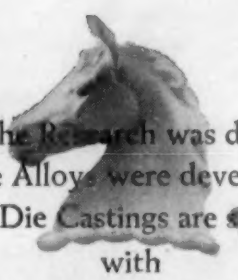
Hirsch (page MA 236 L 9) makes out an interesting case for the use of Ni plated Zn, instead of a steel or brass base for stamped or otherwise fabricated gadgets.—H.W.G.

Affects High Temperature Impact Behavior of Brass

According to Nishikawa and Ito (page MA 250 R 3) a little Fe, Al or Si in a 2: 1 brass markedly influences the high temperature impact behavior.—H.W.G.

General Tom Thumb Among Zinc Alloy Die Castings





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EDITORIAL COMMENT

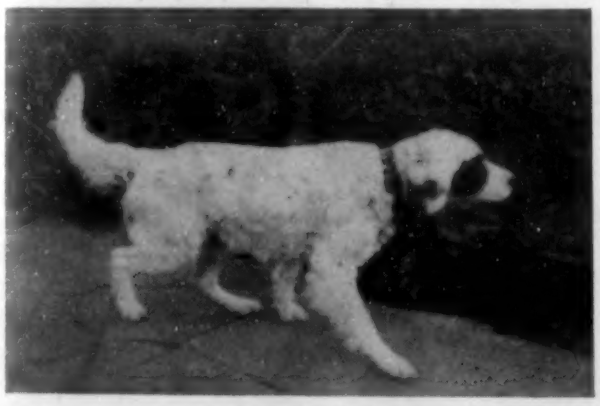
Bird Dogs and Rabbit Hounds

WHEN some one in our research organization comes in and says—"I may be all wet, I think I've got an idea," he reminds us of our setter Flash, as he catches a scent, sniffing the wind, casting back and forth, finally crouching almost flattened on the ground as the scent gets stronger, till finally he freezes on point and says "There it is."

At such times there's no use telling Flash to come along where we want to hunt, he knows better than we where we'll find birds. It would be just as foolish to snap the leash on a research man and take him away from a hot scent.

The plant metallurgist who has to run down a plant problem, or the cause of a customer's complaint, reminds us of the beagle that follows the rabbit till it's shot or holed up. The only trouble with this comparison is that the beagle gives tongue while he's trailing, but the production man generally hasn't enough breath left to do so. We wish, from the Editorial point of view, that a breed of production man could be developed that would more readily tell his fellows what he has found.

Either type of dog is fine in his place. We are always irritated when the setter or the research man deviates from his job to chase the rabbit or the plant troubles, for each has better game to hunt. Nor do we



care to go bird hunting with the beagle, he may scent the bird but he can't hold it and usually flushes it too far ahead for a shot.

An old timer at training setters tells us that it's all right for a young dog to chase rabbits, as it develops his hunting instinct. If we don't curb him, in time he'll get the idea, and settle down to hunting the game his human companion is after and to holding it till he gets there. So the pup metallurgist can well start in the plant. If he's the beagle type he'll stick on that trail. If he's the setter or pointer type sooner or later he'll find his interest in the scent of a new idea and will settle down to research.

Part of the analogy again breaks down here, for while you can tell the breed of a dog by his looks, you can't tell about humans, and the only way to know whether your man is a beagle or a setter is to let him go after both types of game and see how he acts.

But the analogy does hold in one important respect. The executive who is hunting for new products or for improvement in his plant practice may find it without skilled technical assistance, just as he may kick up game without a dog. But lots of executives go through good cover every day and think there is no game there, when a good technical "dog" would find plenty.—H. W. G.

Metals and Airplane Achievements

EIGHT years ago in May, Lindbergh startled the world with his electrifying solo flight to Paris. It has been aptly said that this achievement "sold" to the American people the thing the Wrights had first demonstrated a quarter of a century before at Kitty Hawk. The American people went wild with enthusiasm.

Late in May this year two pilots of the "Lindbergh line" established several new airplane records for speed and endurance which are nothing less than astounding. While the conditions in the two achievements were not the same—one over the wide expanse of the Atlantic and the other on a triangular course over land—there are justifiable comparisons.

The "Spirit of St. Louis" weighed at its take-off 5,150 pounds in all. It covered 3,600 miles to Paris in 33 hours and 30 minutes. The average speed was 107.46 miles per hour. In the recent demonstrations, the Douglas plane, with an "overload" of 7,000 pounds at the take-off, had a gross weight of about 25,000 pounds or nearly five times that of the "Spirit of St. Louis." The Douglas plane flew non-stop 3,105 miles in 18 hours and 22 minutes at an average speed of 169.03 miles per hour. Thus, with a greatly increased load, the more modern plane covered a distance only 500 miles less in about 15 hours less elapsed time and at a speed over 61½ miles faster per hour.

These comparisons indicate to some degree the progress in aeronautics made in the last eight years. To metallurgical engineers these developments call freshly to mind the fact that the records of Tomlinson and Bartles late in May emphasize the value of the contributions of metallurgical research to the aviation industry. The development and perfection of metals and alloys, ferrous and non-ferrous, account in no small measure for the superiority of the modern planes over those of the Lindbergh era.

There is a greater use of the chrome-molybdenum alloy steel as tubing including enhancement in its properties by improved methods of heat treatment and better welding technique. The perfection of various magnesium alloys has been an added source of increased efficiency, as well as wider possible selection of aluminum alloys, accompanied by increased knowledge of proper heat treatment in both types. While the introduction of the variable pitch propeller is

(Continued on page 143)

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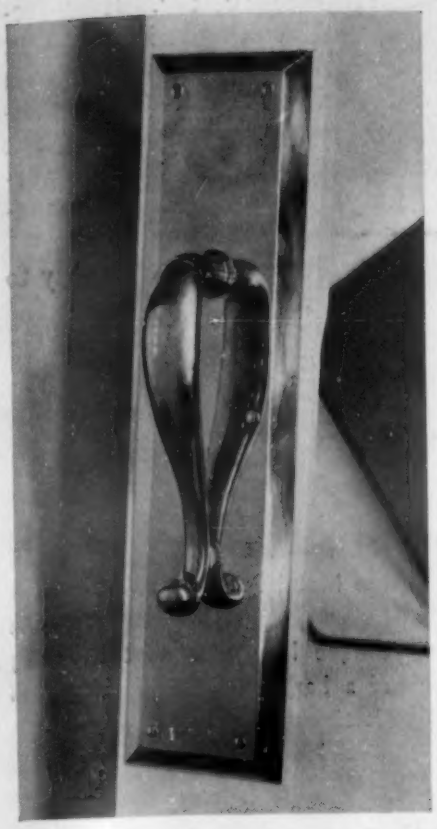


Nickel Silver Door Pull and Escutcheon Plate. (Courtesy of Sargent & Co.)

Foundry Production of Nickel Silver

By T. E. KIHLGREN*

Candlestick Cast in 20 Per Cent Nickel Silver. (Courtesy of Sterling Bronze Co.)

THE NICKEL SILVERS ARE essentially copper-nickel-zinc alloys, and the casting grades generally contain, in addition, tin and/or lead, for reasons which will be later indicated. They are of ancient origin and have been in commercial use for over a hundred years. Many designations have been applied to them and a number are still in use, including German silver, nickel brass, white bronze and Benedict metal; however, the term "Nickel Silver" is in general use and has become accepted without confusion.

The Nickel Silvers owe their importance to their color and durability, to their availability in rolled, drawn, and cast shapes, and to the ease with which they respond to the usual fabricating, brazing, and soldering operations. Not only can essentially "white" alloys of pleasing lustre be obtained, but also, by proper adjustment of composition, pleasing color contrasts involving delicate green, yellow, pink and bluish casts can be secured, a matter of considerable value in architectural applications.

Nickel Silver castings are used for purposes both considerable in number and varied in nature. An attractive appearance, coupled with a useful degree of tarnish resistance and reasonable productive facility, have brought about the use of Nickel Silver for such varied applications as builders' hardware, metal furniture, ornamental metal work, plumbing fixtures, etc. It possesses sufficient corrosion resistance to permit its use in certain types of food handling equipment, and in some cases, chemical equipment. A few of the applications for which nickel silver castings are being used are shown in some of the illustrations accompanying this article.

Three Types of Nickel Silver Alloys

Three fundamentally different types of Nickel Silver alloys are commercially employed and may form the components of a single finished assembly. These are:

I. *The Cold Working Alloys* containing from from 5 to 30 per cent of zinc, and, where free machinability is required, 1 to 3 per cent of lead. The nickel content will range from 10 to 30 per cent depending on the color, strength and tarnish resistance desired.

II. *The Hot Working or Extruding Alloys* which may contain from 8 to 15 per cent of nickel and 38 to 45 per cent of zinc. In addition, certain of the alloys of Type I, containing about 5 per cent of zinc, may be worked hot as well as cold.

III. *The Casting Alloys* which may contain from 12 to 30 per cent of nickel, 5 to 20 per cent of zinc, 2 to 10 per cent of lead and up to about 6 per cent of tin.

While there are innumerable Nickel Silver alloys bearing various proprietary names, they may generally be considered to fall into one of the above classifications.

Systematic data on color, tarnish resistance and hardness of Nickel Silvers containing up to 30 per cent of nickel and 50 per cent of zinc further modified by tin and lead, and data on fluidity, shrinkage and tensile properties of a considerable range of alloys have been presented in a recent paper*, which may be consulted for further information.

Part I—Production of Nickel Silver Castings

THIS article is intended to deal primarily with the founding of Nickel Silver. It is proposed to present first, in their normal sequence, the steps involved in foundry production of Nickel Silver castings, using a procedure which has been found to work well. The remainder of the paper will describe in some detail. and discuss the results of laboratory and foundry experiments from which the procedure for certain of the above steps has been developed.

Casting Mixtures

The more elastic operations of the non-ferrous foundry have resulted in the use of a rather large number of casting mixtures. To some extent, this lack of

* Metallurgist, research laboratory, the International Nickel Co., Inc., Bayonne, N. J.

* "Physical and Casting Properties of the Nickel Silvers." T. E. Kihlgren, N. B. Pilling and E. M. Wise, A.I.M.E. Tech. Pub. No. 610, 1935.

standardization is inevitable. It is the job of the foundryman to produce sound castings from patterns furnished him. When, as is often the case, the design of the casting is faulty, a *reasonable* degree of freedom in modifying the composition to improve the castability offers a legitimate and useful tool to the foundryman.

Most of the casting alloys contain, in addition to copper, nickel and zinc, both tin and lead; the majority contain from 15 to 20 per cent nickel, 5 to 15 per cent zinc, 0 to 4 per cent tin and 0 to 6 per cent lead.

Zinc lowers the melting point and probably tends to minimize gas porosity. Lead aids in securing pressure tightness while tin hardens the alloy; both lower the melting point, improve the fluidity, and favorably influence the mode of distribution of shrinkage. Nickel is the dominant factor in securing whiteness and tarnish resistance; zinc is also beneficial in these respects, although its effect is much less vigorous than that of nickel.

Since the casting mixtures cover such a wide range of compositions, it has been impossible to investigate the effect of variations in founding technique on all varieties of alloys. It has seemed desirable therefore to pick a composition known to possess useful casting and physical properties, and of sufficient commercial importance to be of general interest. Such an alloy is the 20 per cent Nickel Silver alloy conforming to the Federal Specification WWP541, the preferred composition and specification limits of which are as follows:

	Desired Percentage	Maximum Percentage	Minimum Percentage
Nickel	20	..	19
Copper	65	..	62
Zinc	6	10	..
Tin	4	..	2.5
Lead	5	6	..
Manganese	..	1	..
Iron and other impurities	..	1	..

It may be noted in passing that the permissible manganese content (1 per cent) is much higher than is desirable; this element preferably should be under 0.25 per cent. It is preferable to keep the iron below 0.50 per cent, although 1 per cent may be tolerable. Although not specifically mentioned, silicon is highly detrimental and pressure castings in this alloy should preferably contain no more than 0.03 per cent residual silicon.

This 20 per cent Nickel Silver alloy possesses a pleasing color and has found considerable use in plumbing fixtures, builders' hardware, etc. It is frequently used in conjunction with wrought 20 per cent Nickel Silver pipe (20 per cent Ambrac type) with which it provides a suitable color match. Good castings may of course be obtained using mixtures not falling within this specification, and for certain purposes other compositions may be required or be preferable.

While the succeeding comments apply specifically to the "Federal Specification" alloy, the foundry procedure developed, should, with minor variations, be satisfactory for most of the Nickel Silver casting mixtures in general use.

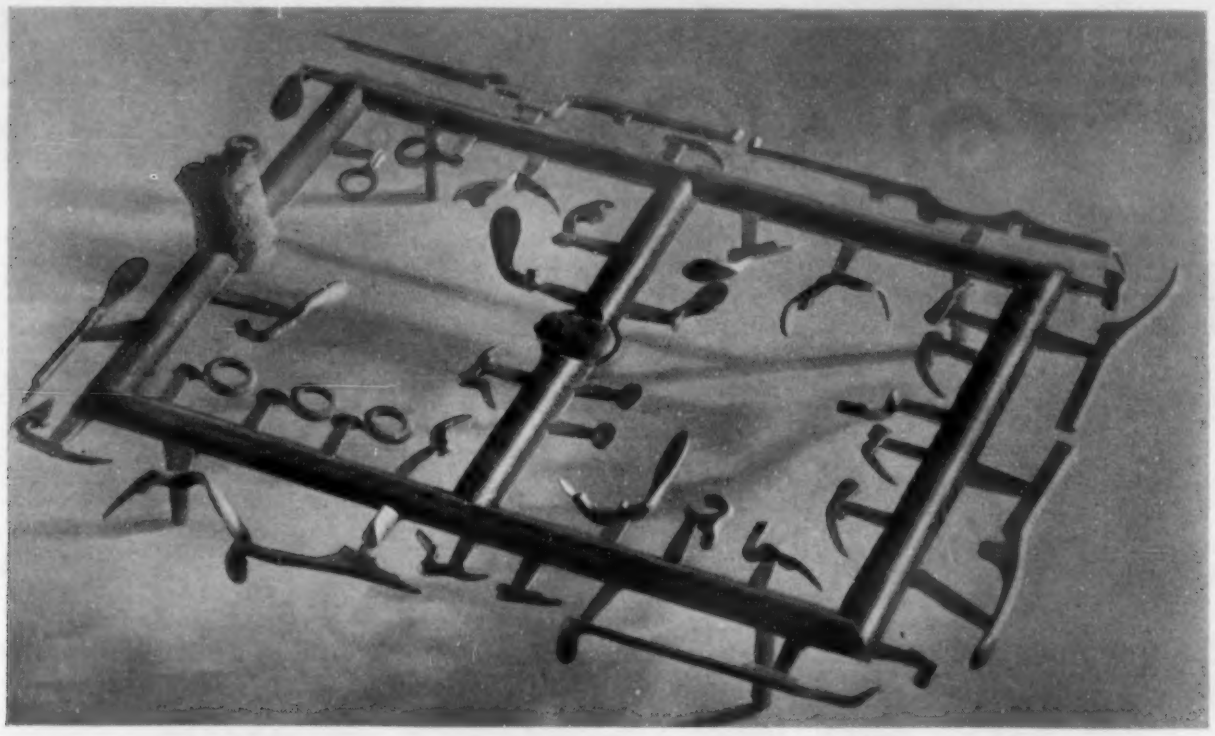


Fig. 3.—A Casting in Which All the Metal Parts for a Clarinet Are Included in One Pattern — An Unique Illustration of the Casting of a Large Number of Very Small Castings. (Courtesy of G. C. Conn Band Instrument Co.)

Each foundry presents a somewhat different problem due to variations in the melting equipment and conditions, to the type of casting generally produced, etc. The development of a suitable foundry technique to meet these conditions therefore requires some experimentation by each foundryman. It is hoped that the following comments will offer a background for working out such a procedure.

Raw Materials

Nickel Silver castings may be prepared from;

(1) Electrolytic nickel, plus ingot copper, tin zinc, and lead.
(2) 50-50 Copper-nickel shot, plus ingot metals.
(3) 2:1 Nickel-copper shot, plus ingot metals.
(4) Prepared ingot.

In all three a reasonable proportion of remelt and scrap (30 to 50 per cent of weight of charge) may be used. With suitable melting equipment, such as oil-fired crucible pit furnaces, good castings may be readily obtained from charges composed of virgin metals (or of virgin metals and clean scrap, preferably revert gates and risers), and such a procedure leads to a maximum flexibility of operation, is economical, and permits close control of undesirable impurities.

Some foundries find it easier to introduce the nickel as shot, due to its lower melting point, and for the average foundry this may be preferable. If added as the pure metal, 1-in. electro-nickel squares are a convenient form for the introduction of nickel. When using shot, it is important to specify a low silicon content, 0.10 per cent or less, and iron and manganese preferably should be under 1.0 and 0.25 per cent respectively.

Some foundries find that their needs are best met

by the use of prepared ingot. Good Nickel Silver ingot, conforming to the Federal Specification WWP541 (as well as other compositions) is obtainable from a number of sources. It is important that the source of supply be one prepared to maintain its purity since, in many cases, scrap metals are used in making up the ingots and may introduce miscellaneous impurities, which increase cumulatively with remelting. It is probably best to buy on specification of composition so that all ingots purchased will be of comparable composition.

Melting Furnaces

While crucible charges may be melted in either oil-fired or coke-fired furnaces, the former is preferable as it provides more rapid melting, and greater ease in meeting the requirements as to pouring temperature. Starting with a hot pit, 150-lb. charges of 20 per cent Nickel Silver made from virgin metal can be melted in about an hour, using oil-fired pit furnaces.

The induction and the indirect arc rocking type electric furnace, as well as the Swartz oil-fired furnace, have also been used to some extent for the production of Nickel Silver castings.

Melting in Crucibles

In loading the crucible, the copper, nickel and return scrap may be put in the initial charge. When shot is used, it can be poured in to fill the spaces in the crucible not occupied by the copper and remelt. Zinc should preferably be added after the cupro-nickel has melted and before the tin and lead as it aids in deoxidizing the melt, and reduces the loss of tin and the danger of tin oxide inclusions. There is some variation in procedure with respect to zinc additions. Frequently a small amount of zinc (about 1½ lb.) is put in the initial charge and some foundries have found it satisfactory to charge most of the zinc into the cold crucible. Tin and lead may be added shortly after the final addition of zinc.

Charcoal covers work satisfactorily for oil-fired crucible pit melting, although it is preferable not to add fresh charcoal after zinc, tin, and lead additions have been made. Glass covers are also being used by some foundries but present the possibility of inclusions of slag in the castings unless skimming is carefully accomplished. Covers containing lime and borax in varying proportions, or borax and boric acid (80:20), have also been used with some success particularly in coke-fired crucible pit furnace melting. These latter fluxes may, however, lead to excessive slagging, and consequently shorten the life of the crucible and generally speaking are unnecessary.

Defective castings may often be due to an excessive melting time, involving long exposure to furnace gases and contamination of the melt; rapid melting is therefore desirable.

Deoxidation of Nickel Silver

After the final additions of zinc, tin, and lead have been made and metal is sufficiently hot, the melt is ready for the deoxidation treatment. The following procedure involving the use of manganese, magnesium and phosphorous has been found satisfactory:

RECOMMENDED DEOXIDATION PROCEDURE FOR NICKEL SILVER—(Mn + Mg + P)

Deoxidizer	Oz. per 100 lb.	Form	Time of Addition
0.10% Manganese..	1½	97% Mangansee metal	5-7 min. before pouring
0.05% Magnesium..	¾	Magnesium (sticks)	3-5 min. before pouring
0.02% Phosphorous	2	15% Phosphor-copper	After crucible or ladle has been brought to mold just before pouring

In crucible melting the *manganese* is dropped in (in a paper bag) while the crucible is still in the pit and the melt then stirred. Immediately after drawing the crucible, the *magnesium* is added (to insure an adequate lapse of time before pouring), by plunging it to the bottom of the crucible. This last precaution is important as otherwise the magnesium will burn on the surface and be entirely ineffective. Some foundries use a length of 1-in. strap iron with an eye rolled at one end to accept the length of magnesium stick to be added; the bar can be readily plunged to the bottom of the crucible. A heavy pair of tongs may also be used, although some chilling of the melt may occur. After the crucible is carried to the molds, 2 oz. of 15 per cent phosphor-copper may be added. This is not essential but is a useful addition, facilitating pouring of the melt.

This deoxidation procedure has been found to work

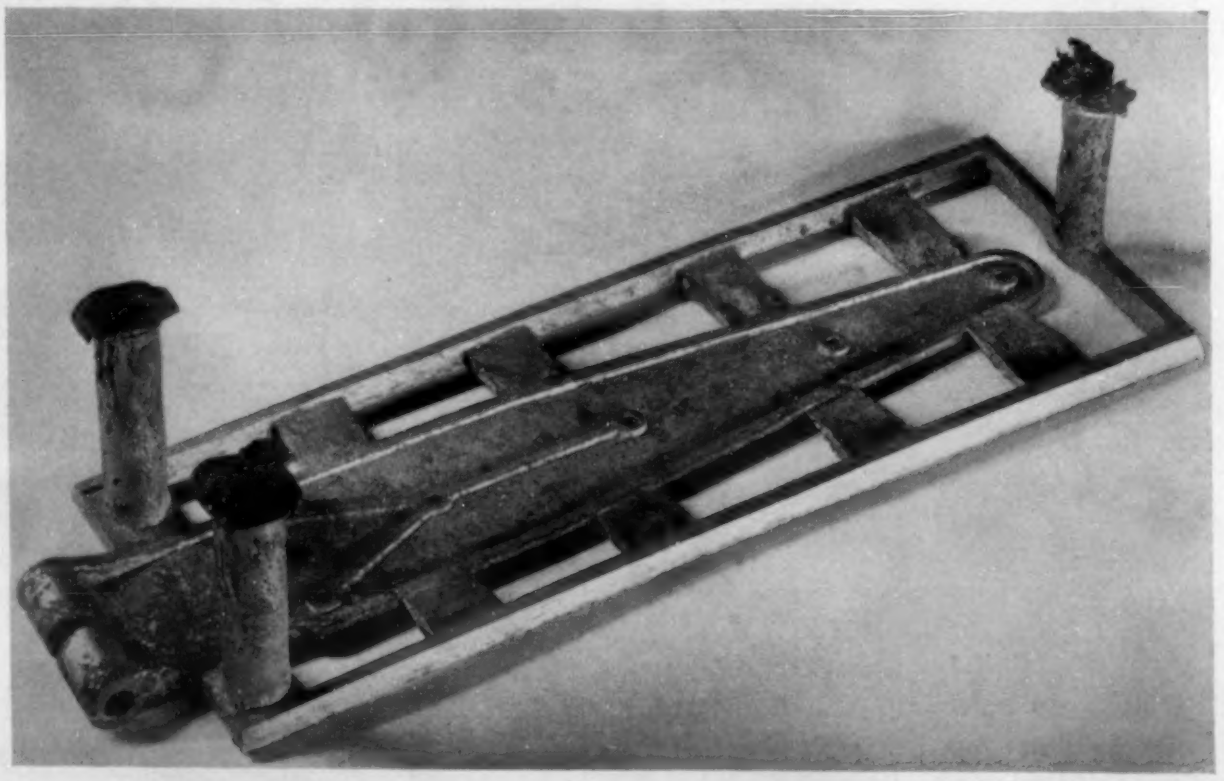


Fig. 4.—A Refrigerator Door Hinge Cast in Nickel Silver with Gates and Risers Attached. (Courtesy Dent Hardware Co.)

well in repeated tests on 150-lb. heats made from virgin metals in the oil-fired pit furnace, yielding pressure tight castings in rather difficult patterns.

When prepared ingot is used, or a considerable portion of the charge consists of remelt, the deoxidation procedure may require some modification. For example, where the ingot contains manganese, it may be found desirable to reduce the amount added in the deoxidation treatment. However, the recommended procedure should prove generally useful.

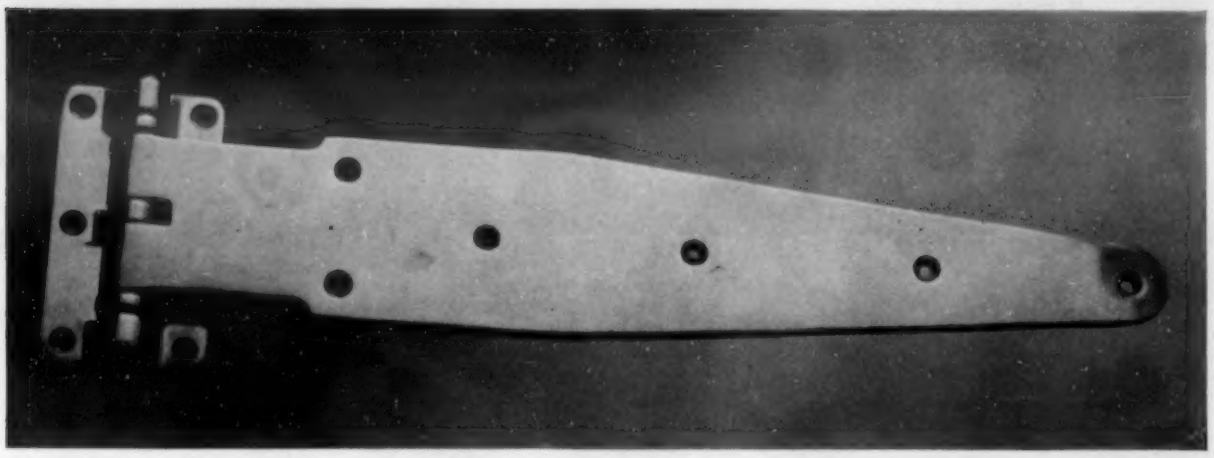


Fig. 5.—The Refrigerator Hinge (Fig. 4) in the Finished Condition. Weighs About 15 lb. (Courtesy Dent Hardware Co.)

Pouring

Generally speaking, Nickel Silver castings should be poured fairly rapidly and it is desirable to choke the gate, so that oxides and dirt may be floated in the sprue. Where a large number of light castings are to be poured, some foundries have found it desirable to limit the charge to 100 lb. to insure that the last castings poured will be within the desired pouring temperature range. This precaution may be particularly necessary where the melting equipment is less efficient. For moderate size castings, 150-lb. crucible melts can be readily handled.

The use of suitable pouring temperatures for Nickel Silver is of extreme importance and generally speaking the tendency is to err in the direction of insufficiently high pouring temperatures. The proper pouring temperature will vary with the composition of the casting mixture; in general, Nickel Silver castings should be poured about 250 to 450 deg. F. above the liquidus.

In the following table, the liquidus temperatures of a number of alloys is given, along with the estimated range of desirable pouring temperatures:

	Composition, per cent					Liquidus, deg. F.	Estimated range of pouring temp., deg. F.
	Ni	Zn	Sn	Pb	Cu		
Benedict metal....	12.5	20	2	10	Bal.	1875	2100 to 2300
18% nickel silver..	18.0	20	..	1	Bal.	2015	2250 to 2450
Fed. spec. alloy...	20.0	6	4	5	Bal.	2055	2350 to 2500
.....	20.0	15	..	..	Bal.	2075	2375 to 2525
.....	20.0	15	2	5	Bal.	2015	2250 to 2450
.....	25.0	20	..	..	Bal.	2075	2375 to 2525

For the Federal Specification alloy a temperature of 2400 to 2450 deg. will be found satisfactory for most castings and the pouring range is from 2500 deg. F. for rather light castings to about 2350 deg. F. for heavy castings of fairly uniform section.

Methods for control of melting and pouring temperature will be discussed at greater length in Part II.

Molding Procedure

While a careful selection of raw material, good control of melting, and a suitable "deoxidation" treatment are all decidedly important, such precautions may be nullified by improper molding procedure. Although each type of casting requires special attention in this respect, certain suggestions as to general procedure may be found useful.

Patternmaker's Shrinkage Allowance: Nickel Silver has a linear shrinkage of 3/16 in. to the foot. This is about the same as for red brass, and some foundries casting both metals find it convenient to use the same pattern for each alloy, with two detachable sets of gates and risers.

Feeding and Gating: It is highly important to make adequate provision for feeding the casting and the use of gates and risers two to three times the weight of those used for red brass is recommended. Rather high temperatures are involved and the metal should be permitted to reach all parts of the mold as soon as possible. The location of the risers is as important as their size. Unless the risers are so located so that they will receive the hottest metal at the end of the pour, they may be harmful rather than beneficial.

Venting: Due to the higher temperatures involved, molds should be considerably more generously vented for Nickel Silver than for alloys of the red brass type.

Sand: It is essential that molding sands for Nickel Silver be more refractory and of higher permeability than those normally used for red brass. As a temporary expedient it may suffice to add "sharp sand" to one of the normally used bronze foundry sands to open it up and obtain a higher permeability.

In our own experimental foundry melts, we have had excellent results with a synthetic molding sand

Fig. 6.—A Sand Cast 20 Per Cent Nickel Silver Faucet. (Courtesy of Standard Sanitary Mfg. Co.

containing 14 per cent clay, balance silica, with a permeability of 60 to 80, and a moisture content of 4.5 to 5.5 per cent. A facing of graphite, dusted on dry, is required with this sand to insure a satisfactory surface on the casting; if this is done the surface of the casting will be smooth enough so that a good polish can be secured by standard polishing and buffing operations.

For the general run of work, a refractory sand with a permeability of 40 to 60, and a moisture content of 5.5 per cent should be satisfactory for Nickel Silver.

Cores: Moderately soft, well vented cores should be used, which will collapse readily and thus prevent excessive stressing of the casting on contracting about the core, minimizing the danger of "hot tears." In other respects core practice for Nickel Silver may follow the lines of ordinary bronze practice.

Summary:

BRIEFLY, observance of the following precautions should aid in the obtaining of good castings in Nickel Silver:

1. Use raw material of adequate purity and appropriate composition.
2. Melt rapidly (preferably under slightly oxidizing conditions).
3. Use suitable deoxidation treatment— (0.10 Mn + 0.05 Mg. + 0.02 P).
4. Pour at sufficiently high temperatures (2400 to 2450 deg. F. for Federal Specification, WWP541, alloy).
5. Fill molds rapidly, without excessive turbulence.
6. Use ample gates and risers (2 to 3 times the weight of those for red brass), properly located on pattern.
7. Vent molds and cores thoroughly.
8. Use fairly open sands and moderately soft cores which collapse readily.

Once more it may be emphasized that each foundry presents its own problem. However, it is hoped that these suggestions will be of some assistance in the foundry production of Nickel Silver castings.

(To be concluded)

EDITORIAL COMMENT

(*Continued from page A-23*)

improved design, the success of this is due in some cases to the new alloy, beryllium-copper, incorporated as bushings, made as forgings, or as sand or centrifugal castings. Aluminum bronze bushings are also entering this picture. Lifting the heavier planes off the ground would not be possible except for the new propeller. There is also a much greater use of duralumin and alclad sheet coverings for wings.

But along with these advances much of the progress must be credited to improved design and to other factors such as the air-cooled engine and its cowling, better aerodynamic design and other factors. A striking fact is that, in contrast to eight years ago, the recent feats of the two American pilots have caused hardly a ripple of excitement. The nation now is surely "air-minded."—E.F.C.

Facts Versus Opinions

SCISSORS and paste-pot are normally considered to be standard editorial apparatus, along with the blue pencil. At any rate, when some one says what we think in better terms than we could state it, quotation is in order, so here goes. Gilligan* says

> According to a prominent steel executive, this is an age of tailor-made steels. Such a state of affairs is not the ideal production schedule a steel maker ordinarily strives for. It is a condition bred by intensive competition arising from sub-normal steel consumption and it is working to the advantage of the steel consumer from a quality standpoint. *Competition is not now confined to the price field, it is a question of quality and service, hence we have the competition of one steel against another; of one alloy against another, and finally, and most important, of the research facilities of one steel company against the research facilities of its competitor.* Out of all this we are destined to have more steels before we have less.
>
> Simplification, if it comes, will require the sympathetic interest and active cooperation of engineers and metallurgists in the steel consuming industries. There will be the need for them to supply precise information on the fundamental requirements of each type of steel as to service and manufacture, to supplement similarly unbiased data on economy of production and uniformity of quality to be provided by the steel maker, *more facts and fewer opinions* from both groups concerning the advantages and disadvantages of the various strengthening elements, with a general willingness to compromise upon a few steels rather than an insistence upon many.
>
> Such simplification would eliminate unnecessary fashions in tailor-made steels, reduce inventories of makers and users, and in time lead to a substantial decrease in the varieties of steels, with consequent increase in the volume of approved types. Decreasing the varieties and increasing the volume is the usual route toward profits. Profits would not be unwelcome to the steel maker, and they should lead to advantages for the steel consumer.

* Gilligan, F. P. "New S.A.E. Steel Data Embodies Wide Engineering Significance." S.A.E. *Journal*, April, 1935, pages 13 to 15.

The italics are ours. These comments are just as true in the non-ferrous as in the ferrous field. As we look back over previous volumes of METALS & ALLOYS and review our plans for the future, we feel that one of our main aims is, and should be, to record the progress of this competition and to substitute fact for opinion.—H. W. GILLETT.

Another Chuckle—Revolutionary Metallurgical Processes

A communication from a lady patent attorney, whose letter-head mentions "Promotions," besides "Patents and Copyrights," seems too good to keep to oneself:

> Dear Sirs: Having been duly impressed with the merits of your worthy institution and the high esteem in which you are held personally, I take the liberty to call your attention to a case which I have good reason to believe should be introduced to you at this time.
>
> The case in mind has to do with the Metals Trades and consists of the two following items, viz.: Process for the Reduction of Coal into its Constituent Elements, Solid, Liquid and Gaseous; the solid product is a metal, instead of coke, and is unique in the fact that it does not expand or contract from molten to cold; the cheapest grade of Bituminous coal yields approx. 400 lb. of this unusual metal, as well as various other valuable by-products.
>
> The second item for consideration is the "Process for the production of Stainless Steel direct from the Ore." Through this method or process we can produce a fine grade of stainless steel in about 6 hr. from the mine.
>
> We would be pleased to have these processes demonstrated in your laboratory there, if suitable arrangements could be effected.
>
> H. W. GILLETT.

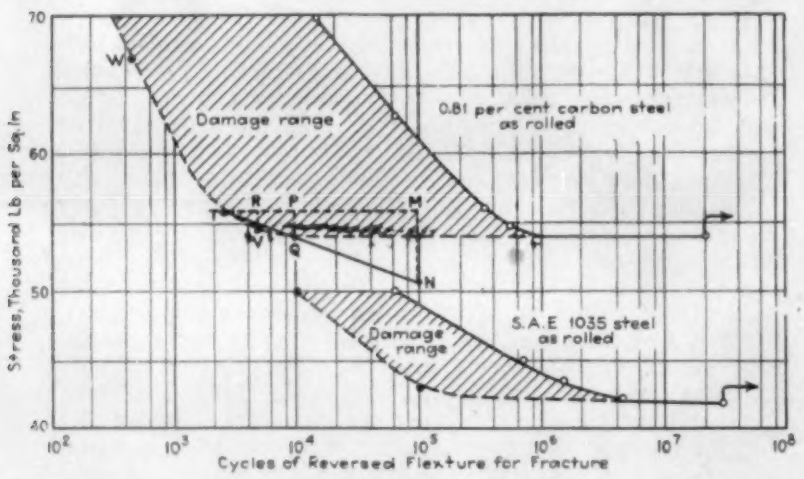
Effect of Occasional Overload on the Strength of Metals

By H. F. MOORE*

THE DEMONSTRATION of the existence of a fairly well defined "endurance limit" under repeated stress has been one of the important landmarks in metallurgy during the past fifteen years. Just as in earlier days first, "tensile strength" and then, the "elastic limit" were hailed as the final solution of the necessary criterion for judging the strength of metals, so this "endurance limit" was hailed as the complete index to strength under repeated stress.

Experience, however, has again shown that we have not yet any single, reliable yardstick for measurement of strength of metals. Three noteworthy papers, written within the past two years, emphasize this point for the fatigue strength of metals, (1) the 1933 A.S.T.M. Marburg lecture by Gough[1], (2) an article by French [2], and (3) a triple article by MacGregor, Burn, and Bacon[3].

Gough's masterful paper gives a picture of the gradual development of a crack after cold working has been going on for some time by repeated slip of material



Metal Subjected to Stress T, (56,000 lb. per sq. in.) for M Cycles of Stress (10^5 cycles) had its Virgin Endurance Limit (54,000 lb. per sq. in.) Reduced by an Amount MN (5,500 lb. per sq. in.). In like manner PQ and RV represent reduction of virgin endurance and the line NQV locates T, a point on the "probable damage line."

along definite atomic planes. We do not know for any given metal just when the predominant effect of cold work ceases to become beneficial and, owing to the start of a destructive spreading crack, becomes destructive.

In French's paper some indication of this change was found by using a test method whereby specimens were given definite numbers of repetitions of stress *above* the endurance limit of the virgin metal, and then, determining the endurance limit of these presumably fatigue-damaged specimens,[5] the amount of lowering of endurance limit of the virgin metal due to these periods of overstress was measured, and a number of cycles for each of various stress determined below which the metal was strengthened, or at least not injured, by a given magnitude of overstress, and above which its endurance limit was lowered. French obtained what he called "probable damage line" and such "damage lines" for two metals are indicated in the illustration which shows test results obtained at the University of Illinois. Obviously metal with a narrow "damage range" (such as the S.A.E. 1935 steel in the diagram) is less quickly weakened by overstress than is a metal with a wide "damage range," such as the 0.81 carbon steel in the same illustration.

In the third paper[3], (METALS AND ALLOYS, Vol. 6, May 1935, page MA 200 R 4) the importance of the sensitivity of different metals to notches, and to what is, perhaps, the worst of notches, a spreading fatigue crack, is discussed, and it is pointed out that the indications at present are that we must study this phenomenon of "stress raisers," and resistance to spread of cracks, by means of tests on larger specimens than we have been accustomed to use.

In this connection it may be noted that, in normal service many, if not most, of our machine parts, and such structural parts as railroad rails, are subjected to occasional stresses above their endurance limit. The ideal of a machine part which never under any circumstances is stressed beyond its endurance limit, seems hardly practicable of attainment, unless in the case of springs provided with stops to prevent excessive deflection. Hence the importance of resistance to spread of fatigue cracks under stresses above the endurance limit.

There has been a good deal of discussion as to the part which mechanical hysteresis plays in giving material the ability to withstand considerable cold work and inelastic action without starting a crack. "Crackless plasticity" is a vivid, (although somewhat inelegant) name proposed for this property. Whether the ability of a metal to absorb considerable energy by hysteresis or its capacity to be strengthened by cold work is the determining factor to give large "crackless plasticity," is an important question. McAdam[4] has presented some evidence in favor of the *ability to be strengthened by cold work* as the dominating factor.

So here again in the field of "fatigue of metals" the "endurance limit," hailed as *the* determining factor for strength, is found to be only a partial index, and the old question "Just when and under what conditions does a fatigue crack start on its destructive spreading course?" is still awaiting an answer.

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* Professor of Engineering Materials, University of Illinois, Urbana, Ill.

[1] Gough. "Crystalline Structure in Relation to Failure of Metals—Especially by Fatigue." *Proceedings*, American Society for Testing Materials, Vol. 33, Pt. II, 1933, pages 3-114.

[2] French. "Fatigue and the Hardening of Steels." *Transactions*, American Society for Steel Treating, Vol. 21, No. 10, Oct. 1933, pages 899-946.

[3] MacGregor, Burn and Bacon. "The Relation of Fatigue to Modern Engine Design." Advance copy of paper presented before North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, England.

[4] McAdam and Clyne. "Influence of Chemically and Mechanically Formed Notches on Fatigue of Metals." *Journal of Research*, Bureau of Standards, Vol. 13, No. 4, Oct. 1934, pages 527-572.

[5] See article by Kommers in *Engineering News Record*, Apr. 18, 1935, page 550, in which it is reported that after having been overstressed for a sufficient number of cycles to lower the virgin enduranace limit, some metals had their virgin endurance limit restored or even increased by subsequent cycles of *understress*.

The Embrittlement of Boiler Steel*—I

A Correlated Abstract

EVERETT P. PARTRIDGE† and W. C. SCHROEDER‡

THE PARTICULAR TYPE of boiler trouble generally characterized by cracking of the plates and rivets along submerged riveted seams has been known for many years as "caustic embrittlement" or simply "embrittlement." This phenomenon has caused more conflict of viewpoints among operating engineers and research investigators than almost any other disease to which boilers are subject. Aside from the discussions of boiler cracking by Hall[1] in 1930, and Hundeshagen[2] in 1932, little, however, has been done to correlate the very considerable amount of information bearing on the subject. The present survey is an attempt to collect the experimental results on record in the scientific and technical literature which may be significant in understanding embrittlement, in order to supply a basis for discussion and for the formulation of further investigations. While a comprehensive bibliography has not been attempted, it is believed that the selected references cited in the following pages contain the most important material in the various fields discussed.

In attempting to organize this review in such a way that the broad significance of the various investigations would not be completely obscured by the details, it has been divided into four mair parts and a final summary. Since embrittlement involves a chemical attack upon steel, the first part has been devoted to a discussion of the chemical reaction between steel and water, including the effect of various dissolved salts. The extent to which chemical attack, in the absence of stress, affects the mechanical properties of steel is considered in the second part of the survey. Since the mechanical properties of steel at boiler temperatures are not the same as at room temperature, this effect, entirely separate from that of chemical attack, is described in the third part. The fourth part is a review of the effects of combined chemical attack and mechanical stress upon the cracking of steel. The final summary includes suggestions for further experimental work.

* Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.) This summary has been prepared in connection with an investigation conducted under a cooperative agreement between the Joint Research Committee on Boiler Feed Water Studies and the United States Bureau of Mines. The general investigation is supervised by a subcommittee of which J. H. Walker is chairman, and is carried out at the Nonmetallic Minerals Experiment Station of the Bureau of Mines, maintained in cooperation with Rutgers University at New Brunswick, N. J. The interpretations and comments in this summary are those of the authors, and the summary as a whole is to be regarded as a report to the subcommittee rather than by the subcommittee.

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‡ Research chemical engineer, Joint Research Committee on Boiler Feed-Water Studies, attached to the Nonmetallic Minerals Experiment Station, U. S. Bureau of Mines, Rutgers University, New Brunswick, N. J.

Chemical Factors in the Attack of Boiler Waters Upon Steel

CORROSION in practice is rarely serious unless it is selective corrosion, that is, unless the process of chemical attack is concentrated in one or more limited regions. Although water in a boiler might react continuously with iron to produce end-products of hydrogen and the black magnetic oxide of iron, no boiler operator would be concerned if the process took place evenly over the surface, because at the slow rate involved the metal would not be seriously weakened until long after the boiler was obsolete. It is only when certain conditions lead to pitting or to embrittlement that the reaction between iron and water becomes a practical menace.

The Reaction Between Iron and Water

The overall reaction between iron and water in the absence of oxygen may be represented by the equation:

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2 \qquad (1)$$

which is simply a material balance stating the initial and final substances. It would be desirable to ascertain what intermediate steps occur during the transformation of the iron surface into the characteristic coating of black oxide, but the mechanism of this re-

action has received little attention. It is distinguished from the ordinary process of corrosion by the fact that it takes place in the absence of any appreciable amount of oxygen.

If iron and water are considered to be the only substances involved, the steps in the chemical process of forming the adherent coating of black magnetic oxide may be pictured as follows:

In water a certain low concentration of hydrogen and hydroxyl ions is always present, as represented by the equation:

$$H_2O \leftrightarrows H^+ + OH^- \qquad (2)$$

Iron placed in contact with water tends to dissolve to a slight extent. The net effect is to produce doubly charged ferrous ions in solution and to discharge

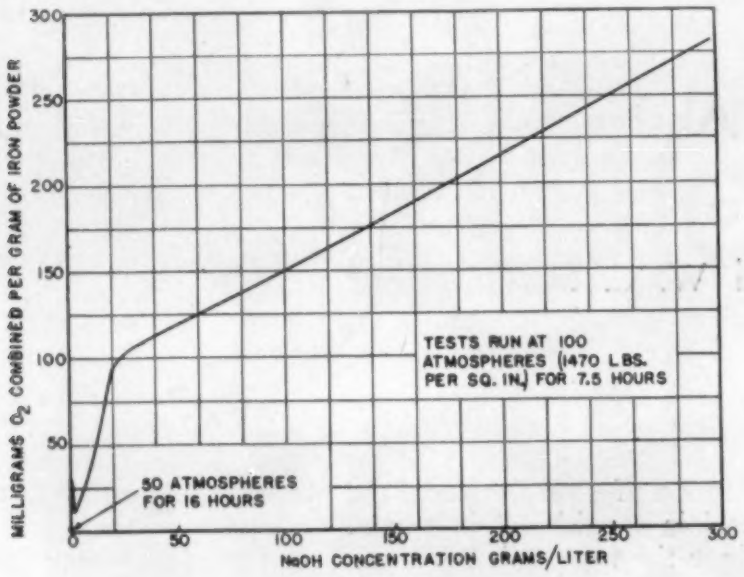

Fig. 1. Relation between Sodium Hydroxide Concentration and Degree of Oxidation of Iron Powder. (All curves from Berl and his co-workers)

from solution an equivalent number of singly charged hydrogen ions as hydrogen atoms on the surface of the solid iron. This step may be written as:

$$Fe(solid) + 2H^+ \leftrightarrows Fe^{++} + 2H \qquad (3)$$

Equations Nos. 2 and 3 together state that when iron is placed in contact with water, hydrogen will be liberated on the iron surface while the water adjacent to this surface will be correspondingly depleted in hydrogen ions and enriched in ferrous ions. The amounts of Fe^{++} and OH^- which can exist simultaneously in solution are, however, limited by the low solubility of ferrous hydroxide, $Fe(OH)_2$, which only dissolves at room temperature to the extent of four parts per million parts of water[3]. As soon, therefore, as the concentrations of Fe^{++} and OH^- exceed a low limiting value, ferrous hydroxide will tend to precipitate, as represented by the equation:

$$Fe^{++} + 2OH^- \leftrightarrows Fe(OH)_2 \qquad (4)$$

Since the Fe^{++} ions originate at the interface between the iron surface and the water, the ferrous hydroxide would be expected to deposit initially in close contact with the metal.

At ordinary temperatures in the presence of oxygen, the hydrogen liberated at the iron surface by Reaction No. 3 is immediately oxidized to water. That hydrogen is actually evolved in easily measurable quantities when iron is placed in contact with water at room temperature in the absence of oxygen has, however, been proved by the experiments of Schikorr[4, 5]. He found that when rusted iron turnings were left in contact with air-free water in a closed system, a pressure of 18 atmospheres of hydrogen slowly developed without any indication that a limit had been reached. Iron wire reacted more slowly, and a piece of iron plate produced no measurable evolution of hydrogen in ten months, although it developed a black coating of oxide in 2 hr. These results may be attributed to the great difference in the surface exposed for reaction. In the case of the iron turnings, it is significant that an increase in temperature from 77 to 95 deg. F. (25 to 35 deg. C.) nearly doubled the rate of evolution of hydrogen.

The experiments by Schikorr[5] indicate that the hydrogen produced is due not only to Reaction No. 3, but also to the formation of Fe_3O_4. The actual steps in this formation are not adequately known, but Schikorr pictures the ionic reactions as

$$3Fe \rightarrow 3Fe^{++} + 6\,\Theta \qquad (5)$$
$$2Fe^{++} \rightarrow 2Fe^{+++} + 2\,\Theta \qquad (6)$$
$$8\,H_2O \rightarrow 8H^+ + 8\,OH^- \qquad (7)$$
$$8\,H^+ + 8\,\Theta \rightarrow 4H_2 \qquad (8)$$
$$Fe^{++} + 2Fe^{+++} + 8\,OH^- \rightarrow Fe_3O_4 + 4H_2O \qquad (9)$$

which implies that ferrous hydroxide is not necessarily deposited as an intermediate solid phase, as in Reaction No. 4, but that Fe_3O_4 may be produced from solution directly at the iron surface.

Whether or not ferrous hydroxide appears as a solid during the course of the reaction, the net result is indisputably the continuous evolution of hydrogen and the accompanying deposition of Fe_3O_4 as long as water can come in contact with iron. The same reaction to produce hydrogen has been observed by Fuller[6] at 122 deg. F. (50 deg. C.), by Baylis[7] at the atmospheric boiling point, and by Berl, Staudinger and Plagge[8] at temperatures in the boiler range. Berl and van Taack[9] found by X-ray studies that the oxide coating produced at boiler temperatures was Fe_3O_4 containing excess FeO.

The fundamental reaction just described is always taking place to some extent in every boiler during operation. The composition of the boiler water may affect the rate at which iron is converted into an oxide coating and hydrogen is liberated, but the essential process is the same in a boiler using distilled water as in one operating with a high concentration of salts. The process will not stop until the water is prevented from reaching the iron, as, for example, by the development of a layer of oxide which is continuous and impervious.

Effect of Dissolved Substances

The effect of various dissolved substances upon the fundamental reaction must now be examined. Berl and his students[8, 9, 10, 11, 12], have performed a notable series of investigations on this subject under the sponsorship of the Boiler Water Committee of the Verein deutscher Ingenieure. Their primary object was to study the reaction between steel and solutions of sodium hydroxide, and the effect of added salts, particularly sodium sulphate, upon this reaction. In all of this work steel powder obtained by sawing selected boiler plate was sized by screening, and a definite quantity of closely sized powder was introduced into a bomb with a solution of known composition. The bomb was then placed on a shaking device and heated for a definite period of time, after which it was cooled and the amount of hydrogen evolved and oxygen combined with the steel were determined.

The results presented in the first paper of this series[8] are not strictly comparable with those from the subsequent papers because of changes in experi-

mental technique. In the earlier work, the bombs were maintained at constant pressure, with a resultant decrease in temperature during an experiment as a result of the evolution of hydrogen, while in the later work, the bombs were held at constant temperature and the pressure was allowed to increase as hydrogen formed. Moreover, the degree of oxidation calculated in the earlier work is based upon a different analytical procedure than the values in the later papers. A critical comparison may nevertheless be made of these two groups of results, if some allowance is made for the difference in technique.

In considering the following excerpts from the work of Berl and his students, it should be remembered that steel in a finely divided condition was employed in order to present a large surface for reaction. The quantities of hydrogen evolved and oxygen combined by 5 grams of the steel powder used would accordingly correspond to the attack upon a large area of boiler plate under the same conditions of time, temperature and concentration.

Sodium hydroxide: The attack of solutions of sodium hydroxide upon steel increases with concentration and with temperature. Fig. 1 indicates graphically that the degree of oxidation produced by low concentrations of sodium hydroxide is almost vanishingly small at 50 atmospheres (735 lb. per sq. in)[13] but definitely more pronounced, though still small, at 100 atmospheres (1470 lb. per sq. in.)[14], corresponding to a temperature of approximately 590 deg. F. (310 deg. C.)*. Increase in concentration of sodium hydroxide greatly accelerates the attack, with the exception of a narrow range at approximately 0.7 gram of NaOH per liter where a slight protective effect is evident.

Other sodium compounds: When solutions of disodium phosphate, sodium nitrate, sodium chloride and sodium sulphate were tested independently at 100 atmospheres, corresponding to 590 deg. F. (310 deg. C.)*, the results shown in Fig. 2 were obtained[15]. At corresponding concentrations on the weight basis, all of these sodium salts attacked steel less than sodium hydroxide, with the exception of a slight deviation at the lowest concentrations of sodium sulphate. The negligible attack at higher concentrations of sodium sulphate and the slight attack produced by sodium chloride as compared with sodium hydroxide are brought out clearly by Fig. 2. In the original paper a curve was also given for sodium sulphate at 200 atmospheres, corresponding to a temperature of 687 deg. F. (364 deg. C.)* The higher concentrations indicated on this curve could not, however, have been obtained, since solubility determinations made by the writers indicate that at this temperature only about 10 grams of sodium sulphate per liter can remain dissolved in the solution. When corrected on this basis, the data show no effect of temperature greater than the probable experimental variation.

Sodium hydroxide plus other sodium compounds: Each of the four sodium compounds which independently attacked steel less than sodium hydroxide, when added to sodium hydroxide reduced its attack. This effect is depicted in Fig. 3, which represents tests made at 590 deg. F. (310 deg. C.)[16]. Sodium chloride was least effective of the added substances, particularly at the higher concentrations of sodium hydroxide, in contrast to sodium sulphate which greatly reduced the attack. It is particularly significant that a low concentration of sodium sulphate was apparently about as effective as a high one. In single tests sodium nitrate and sodium phosphate showed considerable protective effect.

Although sodium sulphate by itself did not attack steel and when added to sodium hydroxide markedly depressed the action of the latter, this protective effect was destroyed by the presence of sodium chloride. Tests run at 590 deg. F. (310 deg. C.)[17], are shown in Fig. 4. These indicate that at a constant concentration of 14.2 grams of sodium sulphate per liter a much greater attack on the steel was induced by 5.9 than by 29 grams of sodium chloride per liter added to the sodium hydroxide solutions. The attack by caustic solutions to which both sodium sulphate and the lower concentration of sodium chloride had been

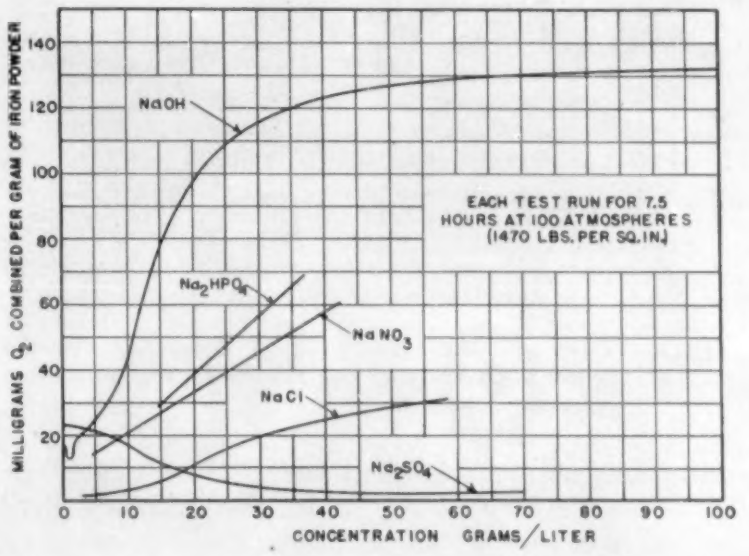

Fig. 2. Degree of Oxidation of Iron Powder Produced by Various Sodium Compounds.

added even exceeded that produced by corresponding concentrations of sodium hydroxide.

Other substances: The oxidation produced in the presence of potassium chromate and dichromate, sodium bisulphate, sodium sulphite, magnesium chloride, hydrochloric acid, and various combinations of these substances with sodium sulphate and sodium chloride is also reported by Berl and van Taack[11].

With the exception of sodium nitrate, which proved sufficiently powerful as an oxidizing agent to cause the formation of ferric oxide, (Fe_2O_3), the solutions in the preceding tests, regardless of composition, produced the same two end-products, hydrogen and a coating of black magnetic oxide (Fe_3O_4) on the steel. No specific reaction, such as the one proposed by Thiel[18], in which sodium produced by the reaction

$$Fe + NaOH \longrightarrow Fe(OH)_2 + Na \qquad (10)$$

formed a surface alloy with the iron, was found by Berl, Staudinger and Plagge[9]. Apparently the varying degrees of attack by different solutions were due not to different reactions, but to different rates at which the fundamental reaction between iron and water proceeded in the presence of various dissolved substances. The part which the coating of iron oxide may play in determining the rate of this reaction will now be discussed.

Protective Action of Oxide Coating

The present writers believe that the difference in rates of reaction may be explained most reasonably by assuming that the oxide coating acts as a mechanical barrier tending to prevent the water from making con-

* The values for pressure and temperature are those given respectively in references[9] and [1]. According to the accepted steam tables in use in the United States they are somewhat out of agreement.

tact with the iron. Certain substances, such as sodium hydroxide in low concentration and sodium sulphate, tend to produce a denser or less permeable coating, thus slowing down the observed chemical attack. Sodium hydroxide in high concentration, like dilute sulphuric acid, tends, however, to destroy the layer of oxide, or to prevent its formation, thus accelerating the attack.

Evidence supporting the viewpoint that the oxide

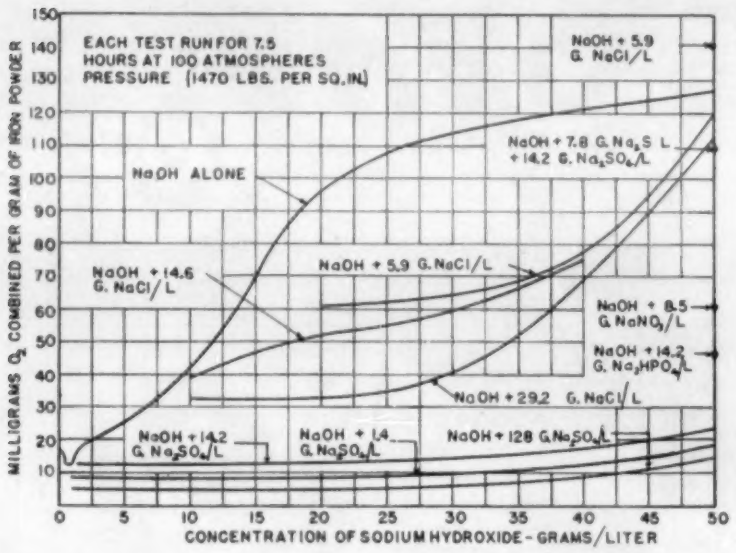
EACH TEST RUN FOR 7.5 HOURS AT 100 ATMOSPHERES PRESSURE (1470 LBS. PER SQ. IN.)
NaOH + 5.9 G. NaCl/L
NaOH + 7.8 G. Na2S L + 14.2 G. Na2SO4/L
NaOH ALONE
NaOH + 14.6 G. NaCl/L
NaOH + 5.9 G. NaCl/L
NaOH + 8.5 G. NaNO3/L
NaOH + 14.2 G. Na2HPO4/L
NaOH + 29.2 G. NaCl/L
NaOH + 14.2 G. Na2SO4/L
NaOH + 1.4 G. Na2SO4/L
NaOH + 128 G. Na2SO4/L
MILLIGRAMS O2 COMBINED PER GRAM OF IRON POWDER
CONCENTRATION OF SODIUM HYDROXIDE - GRAMS/LITER

Fig. 3. Effect of Sodium Sulphate and Other Salts on the Degree of Oxidation of Iron Powder Exposed to Sodium Hydroxide Solutions.

coating acts as a mechanical barrier is available from several sources. Fuller[19], in his experiments with a seamless iron tube arranged as the cathode of an electrolytic cell, found that the rate of diffusion of hydrogen through the iron was much less when the cell contained tap water or a 1 per cent solution of sodium hydroxide than when a 1 per cent solution of sulphuric acid was employed. The higher rate in the latter case may be attributed to the elimination of the oxide barrier by the sulphuric acid.

Another experimental observation which may be significant was made by Langdon and Grossman.[20] Electrolytic pickling of steel in a solution containing 280 grams of sodium sulphate per liter produced very little, if any, brittleness, although the cathode plates evolved hydrogen vigorously. Similar treatment in dilute sulphuric acid made steel brittle. It seems that in the case of the sodium sulphate the penetration of hydrogen must have been retarded by the development of a nearly impervious oxide coating. The marked effect of sodium sulphate in producing a passive condition in iron has been observed by many investigators.

The results obtained by Berl and his co-workers may be interpreted in terms of a layer of iron oxide, the protective effect of which is dependent upon solution composition. The course of the curve in Figure 1, for example, is probably due to the fact that low concentrations of sodium hydroxide assist in producing a more protective oxide coating, while higher concentrations have the opposite effect. In this connection it is interesting to note that Grube and Gmelin[21], in the course of electrolytic studies of the formation of alkali salts of the iron oxides, have observed the solution of iron in 40 per cent sodium hydroxide at 80 deg. C. to yield the sodium salt, Na_2FeO_2. Expressed in terms of ions the reaction would be

$$Fe^{++} + 4OH^- \leftrightharpoons FeO_2^{--} + 2H_2O \qquad (11)$$

This process, which may be considered analogous to the solution of aluminum in concentrated solutions of sodium hydroxide to form sodium aluminate, is favored by low current density and increased temperature, and hence may be important under boiler conditions. During electrolytic oxidation of the solution of Na_2FeO_2 in 40 per cent sodium hydroxide to form $Na_2Fe_2O_4$, these investigators further noted that Fe_3O_4 was deposited as a black suspension. They suggest that this results from the reaction:

$$Na_2FeO_2 + Na_2Fe_2O_4 + 2H_2O \leftrightharpoons 4NaOH + Fe_3O_4 \qquad (12)$$

If this is correct, the reaction in the reverse direction may be considered as a process by which Fe_3O_4 dissolves in sodium hydroxide to produce soluble sodium salts of ferrous oxide and ferric oxide. High concentrations of sodium hydroxide might therefore be expected to have a destructive effect upon the layer of Fe_3O_4 on an iron surface exposed to solutions at boiler temperatures.

This hypothesis is supported by tests performed by Berl and van Taack [22]. Using the experimental method previously described, they first produced a layer of Fe_3O_4 on their steel powder by treatment with water or various solutions in a bomb at 590 deg. F. (310 deg. C.). The powder was then removed, washed thoroughly to remove any dissolved salts when these had been employed, and returned to the bomb for a test with sodium hydroxide solution. As is evident from Fig. 5, the oxide layer resulting from the pretreatment effectively protected the steel from attack by solutions containing up to 50 grams of sodium hydroxide per liter, but at a concentration of 75 grams of sodium hydroxide per liter the oxide layer must have been removed to a considerable extent. Berl regards 50 grams per liter as the maximum concentration of sodium hydroxide in which the oxide film is stable at 590 deg. F. (310 deg. C.), since sodium sulphate in solutions of sodium hydroxide also begins to lose its protective effect under these conditions, as may be seen in Fig. 3.

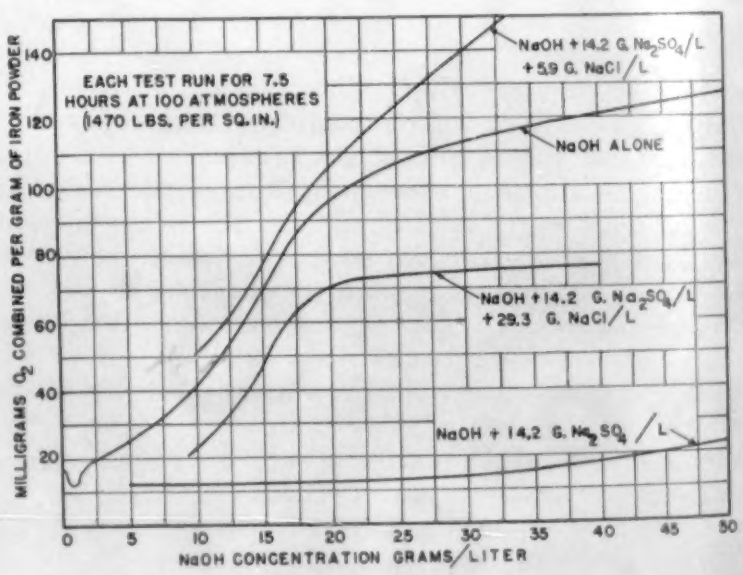
EACH TEST RUN FOR 7.5 HOURS AT 100 ATMOSPHERES (1470 LBS. PER SQ. IN.)
NaOH + 14.2 G. Na2SO4/L + 5.9 G. NaCl/L
NaOH ALONE
NaOH + 14.2 G. Na2SO4/L + 29.3 G. NaCl/L
NaOH + 14.2 G. Na2SO4/L
MILLIGRAMS O2 COMBINED PER GRAM OF IRON POWDER
NaOH CONCENTRATION GRAMS/LITER

Fig. 4. Effect of Sodium Chloride in Reducing the Protective Action of Sodium Sulphate on Iron Powder Exposed to Sodium Hydroxide Solutions.

Some emphasis should be placed at this point upon the observation of Evans[23] that the greatest degree of protection against corrosion is afforded, not by an obvious layer of oxide, but by one so thin that it is invisible until it has been isolated from the metal surface. To the present writers it seems quite possible that the relatively thick black coating of oxide characteristic of steel exposed to water at elevated temperatures may have some protective effect because

it slows down the rate at which water can reach the actual interface between metal and oxide, but that the condition of the oxide layer at the interface itself may be a more important factor in determining the rate of reaction.

Electrochemical Behavior of Oxide Coating

Although the oxide coating may protect the underlying steel if it is continuous, any opening will tend to be the seat of rapid localized chemical attack. The part which Fe_3O_4 as mill scale plays in the corrosion of iron at ordinary temperatures has been summarized by Speller[24]:

> ". . . where iron is almost completely covered by a cathodic conductor, such as mill scale or lead, the smaller unprotected iron areas will corrode with great rapidity, especially if the solution has a high electrical conductivity. The depth of pitting, within limits, varies indirectly as the ratio between the anodic area exposed, and the area covered with scale or other cathodic material, if the latter is kept saturated with hydrogen. The mill scale (magnetic oxide of iron—Fe_3O_4) commonly found on the surface of iron and steel probably gives rise to more localized corrosion in service than any other combination of dissimilar materials."

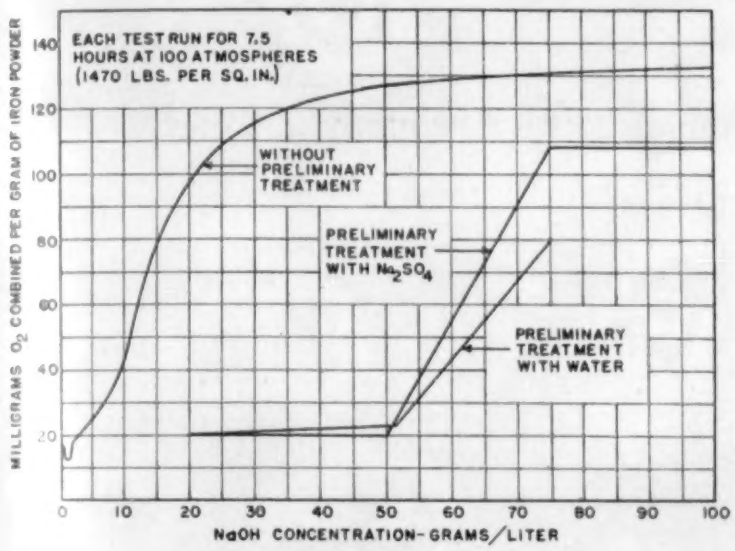

Fig. 5. **Effect of Preliminary Treatment of Iron Powder on Degree of Oxidation by Solutions of Sodium Hydroxide.**

A similar action of the layer of Fe_3O_4 produced on iron by reaction with water would be expected at elevated as well as at ordinary temperatures. The physical character of the oxide coating therefore may determine whether it acts as a barrier to stop chemical attack or whether it induces accelerated local corrosion.

Although an iron plate exposed to water at room temperature in the absence of oxygen evolved no measurable amount of hydrogen in 10 months[5], indicating that the oxide layer was an effective barrier under these conditions, in most cases the reaction between iron and water slowly continued. W. J. Müller[25] has come to the conclusion that the passive condition of metals is caused by the development of a protective coating, which, however, is not complete but instead contains very small pores. In the case of iron in contact with a solution, the oxide and the metal exposed in a pore thus form the electrodes of innumerable tiny electrolytic cells. The local potential difference in these cells, and hence the intensity of the electrochemical action tending to dissolve iron, will be affected by such factors as solution composition and temperature.

Until further evidence is supplied, the oxide coating must be regarded as an uncertain factor in the reaction of complex solutions with steel at elevated temperatures, and hence in the question of embrittlement. The probability that it plays a dual role should be considered in any attempt to formulate a general theory.

Conclusions

In the preceding discussion attention has been concentrated on the chemical behavior of iron in water or various solutions. This information in itself is not adequate to explain embrittlement, but it does provide a necessary background for an understanding of the chemical factors in the embrittlement process. The considerations which seem most significant may be summarized as follows:

1. In the absence of oxygen, water reacts with iron at ordinary or elevated temperatures to produce hydrogen and a coating of black magnetic oxide (Fe_3O_4) on the iron surface.

2. The oxide coating acts as a mechanical barrier tending to separate the iron from the water and thus to slow down the rate of reaction.

3. Various substances in solution tend to destroy or maintain the oxide coating, thus affecting the rate of reaction. Low concentrations of sodium hydroxide tend to produce a coating with the greatest protective qualities. Increasing concentrations of sodium hydroxide, disodium phosphate, sodium nitrate and sodium chloride decrease the protective effect, in contrast to sodium sulphate which apparently tends to produce a highly protective coating.

4. When several substances are present in solution, the net effect may differ from that anticipated from the effects of the individual constituents. Thus the protective action of sodium sulphate against attack by sodium hydroxide is offset by the addition of sodium chloride.

5. Any discontinuities in the oxide coating will tend to accelerate localized chemical attack.

(To be continued)

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[13] Reference (8) Fig. 4. The temperature corresponding to the stated pressure cannot be evaluated precisely, but is probably about 510 deg. F. (266 deg. C.).

[14] Reference (9) Figs. 3 and 5; Reference (11) Figs. 3 and 4.

[15] Reference (9) Fig. 10. Concentrations were expressed in mols per liter in the original publication, but have been converted to grams per liter in Fig. 2 of the present paper.

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[17] Reference (10) Fig. 3; Reference (11) Fig. 25.

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Utilization of Electrical Resistance Measurements for Controlling the Composition of Alloys

With Special Reference to the Determination of Antimony in Lead

By EARLE E. SCHUMACHER* and LAWRENCE FERGUSON*

IN THE COURSE OF large scale commercial work with metal and alloys, it is often necessary to analyze samples at frequent intervals in order to control chemical composition. In most instances, wet chemical methods are used for analysis, even though they are generally laborious, expensive, and time consuming. One process, in which frequent analyses are required for controlling the quality of a product, is the commercial extrusion of lead-antimony cable sheath, where the antimony content should be held between 0.90 and 1.10 per cent. The most accurate wet method of analysis available for this control (and the one commonly used) gives results accurate to ±0.03 per cent antimony[1]. This method is sufficiently costly and time consuming, however, to warrant the development of rapid and inexpensive supplementary means of indicating antimony content.

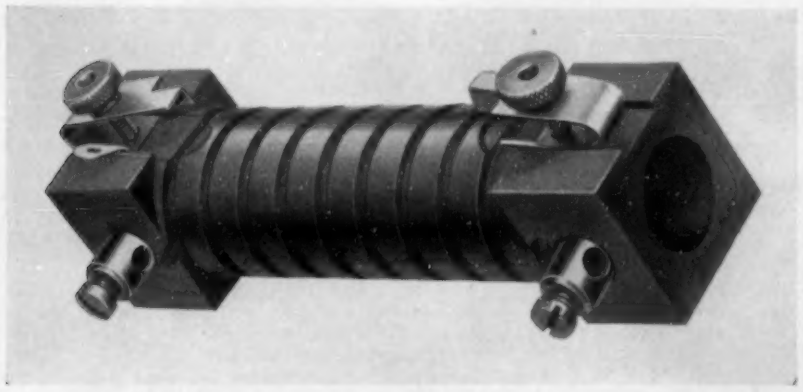

Fig. 1—Conductivity Jig.

There are many ways available of checking the composition of alloys but only a few seem to have been developed into simple practical methods. Thus, the thermoelectric effect is sometimes used for indicating the purity of platinum, the spectroscope is used for determining the composition of metals, and electrical resistance requirements are set by the A.S.T.M. specifications[2] for copper. It seems, however, that the tremendous effect of small quantities of some elements in solid solution in a metal on its electrical resistance should be the basis of more commercial methods of controlling composition than are used at present.

To stimulate interest in the more general use of the electrical resistance of solid solutions for indicating the composition of alloys, details concerning one application are set forth in this paper. While for other systems certain elements of the method as outlined here might have to be modified, it appears that the general principle could be advantageously utilized in many instances. This paper presents, therefore, a practical resistance method of supplementing ordinary chemical analyses in the determination of the antimony content of lead-antimony alloys ranging at least from 0.4 to 1.1 per cent.

Theory

The electrical resistance of almost all metals is greatly increased by the presence in them, in solid solution, of comparatively small amounts of other elements. Moreover, this increase in resistance of the metal, within certain composition limits, is approximately proportional to the amount of other materials present. Lead-antimony alloys are a typical instance of this phenomenon, the resistance of the alloy increasing rapidly with increase in the amount of antimony in solid solution in the lead.

In order to utilize this principle for determining the amount of antimony in a lead-antimony alloy, therefore, it is necessary to determine the relationship between electrical resistance and antimony content for

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a series of alloys in which all of the antimony is in solid solution. Antimony up to 2.45 per cent[3] will dissolve in lead in the solid state, if the mixture is heated for a sufficiently long time at a suitable elevated temperature for phase equilibrium to be established at that temperature. If the alloys are then rapidly cooled to about room temperature, the antimony (in those alloys not containing too great an amount) will remain in solution long enough for adequate resistance measurements to be made, even though the alloy is not in stable equilibrium.

There are, of course, limits to the range of antimony contents which can be reliably indicated by resistance measurements. Thus, as the concentration of antimony falls, the difficulty of distinguishing between it and various impurities must necessarily increase. An obvious upper limit for antimony determination is 2.45 per cent the maximum solid solubility. Beyond this point the resistance continues to increase with increase in antimony content, but the rate is very greatly reduced. A practical upper limit may be set somewhat lower than 2.45 per cent antimony, however, because of the fact that, at this high concentration, the precipitation of antimony from solid solution may become too rapid for the measurement of resistances. Although, in connection with the present paper, the authors have worked only with alloys containing from 0.4 to 1.1 per cent antimony, they believe from their other experience with these alloys that the practical range can be extended to at least 0.2 to 2.0 per cent antimony.

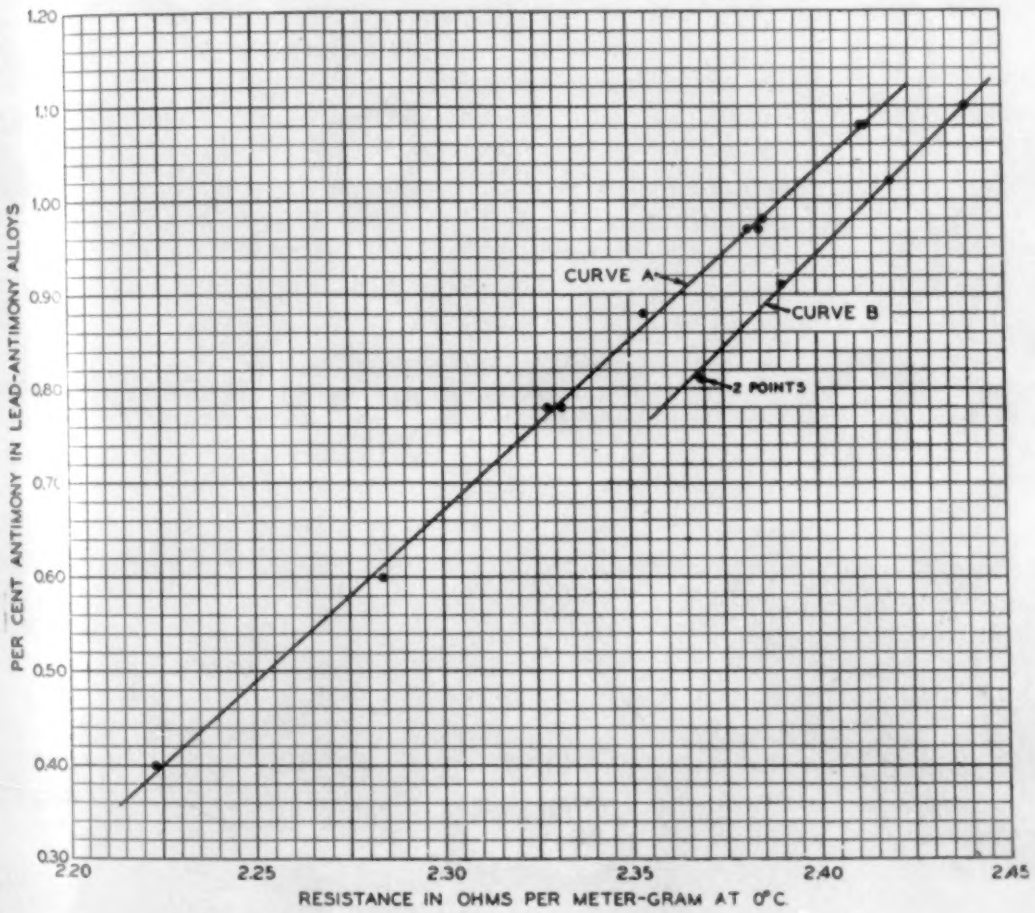

Fig. 2—Resistivity of Lead-Antimony Alloys. Curve A—made from A.S.T.M. Grade II Lead. Curve B—made from "High Purity" Lead.

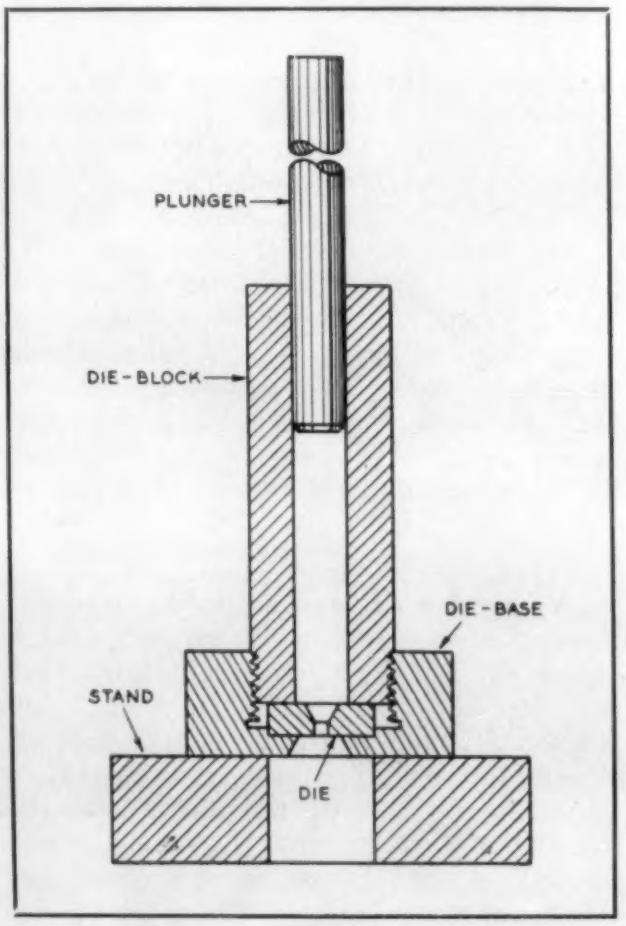

Fig. 3—Miniature Extrusion Press.

Some Factors Involved

Factors other than high concentration may increase the rate of precipitation of antimony from solid solution in lead. Some impurities, notably arsenic, cause a rapid precipitation of antimony, but these are never present naturally in amounts sufficient to reduce dangerously the allowable time for resistance measurement. The most important factor increasing the rate of precipitation of antimony is cold working. Cold working has so great an effect on lead-antimony that it should be avoided after the antimony is once put into solution.

Since the electrical resistance of a lead-antimony alloy is affected by the presence of small quantities of impurities as well as by antimony content, it is necessary to know what part of the electrical resistance is due to them. Generally, however, raw materials from a particular source, or made by a particular process, contain very nearly the same amounts and kinds of impurities. The A.S.T.M. has drawn up specifications[4] for three different grades of lead which set a limiting range on the concentration of each impurity. In addition, there are also certain well known brands of high purity lead (i.e., "Bunker Hill," "Doe Run," "St. Louis Refined," etc.) whose impurity content is very nearly constant.

The resistance of lead-antimony alloys made from a single grade or type of lead has never been found by the authors to vary more than a negligible amount as a result of variation in the impurity content of the lead used. It seems advisable for precise determinations, however, to check each separate lot of lead used. No information on reclaimed lead is available, but it seems unlikely that the variation in impurity content of any particular reclaimed lead should be troublesome. Although variations in the impurity content of a particular grade of lead may not be important, the difference in effect on electrical resistance between some different grades of lead is sufficient, as shown below, to necessitate the construction of separate resistance curves for each grade.

Apparatus and Procedure

In order to estimate the amount of antimony in a lead-antimony alloy by a simple resistance measurement, it is obviously necessary to standardize or elim-

inate all variables affecting resistance except that of antimony content. This can be done simply by maintaining standard conditions, developing a standard procedure, and, as described above, constructing different resistance-antimony content curves for each grade of lead used.

The particular method by which a specimen is shaped for resistance measurement is comparatively unimportant, so long as the finished specimen is sound. For this reason, only the sound parts of castings should be used and extruded material should be free from dross. With low melting point alloys, such as those with a tin or lead base, a specimen for test may be obtained conveniently by casting a slug approximately ½ in. in diameter and 3 in. long. This bar can be swaged and drawn to wire 0.08 in. in diameter, or some similar convenient size, and the wire mounted in a convenient type of apparatus for subsequent heat treatment and electrical measurement.

Fig. 1 shows a lavite jig used with lead-antimony alloys. As shown, the jig is fitted with current and potential contacts for resistance measurement by the standard potentiometric method. After winding a lead-antimony wire on the jig, the whole assembly is heated at about the eutectic temperature, 247 deg. C., in an oil bath, for about 15 min. in order to put all of the antimony in solid solution and to homogenize the alloy. The apparatus is then quenched in cold water, quickly rinsed in carbon tetrachloride to remove grease, immediately immersed in a mixture of cracked ice and water at 0 deg. C. The resistance measurement should be made between 5 and 10 min. after immersion in the ice-water mixture.

By taking account of the length and weight of the wire, its resistivity can be calculated in ohms per meter-gram (resistance of a wire one meter long and weighing one gram) and directly correlated with antimony content. This calculation can be simplified in practice because the length of the wires will be constant, their weight nearly so, and the specific resistance or antimony content can be read from charts.

Experimental Results

A number of lead-antimony alloys containing different amounts of antimony were made from Grade II A.S.T.M.[4] lead and from high purity leads such as "Bunker Hill" and "St. Louis Refined." These were subjected to the treatment described above, and their electrical resistance at 0 deg. C. was measured. The composition of the alloys was then determined by the best wet chemical method available, which as stated above gives results good to ±0.03 per cent antimony. The data obtained from the alloys made of A.S.T.M. Grade II lead are shown plotted as Curve A in Fig. 2, while those for the high purity lead alloys are plotted as Curve B.

Discussion

Inspection of Fig. 2 shows that Curves A and B are straight lines, that the maximum deviation in the resistance data corresponds to not more than ±0.01 per cent antimony, and that a 1 per cent change in resistance is produced by a change in antimony content of less than 0.1 per cent. This indicates the marked precision of which the resistance method is inherently capable. The difference between Curves A and B is evidence of the effect of the different impurity content of the two grades of lead used. Curve A may be considered accurate for antimony alloys with any A. S. T. M.[4] Grade II, or "chemical" lead, a classification including St. Joseph, Federal, and other brands. Similarly, Curve B may be considered accurate for alloys made from any "high purity" lead of a type such as "Bunker Hill," "Doe Run," and "St. Louis Refined." Sufficient data have not been obtained from alloys made from A.S.T.M.[4] Grade I lead (bismuth bearing) or other types for the construction of curves, but, if these curves are desired, the necessary data for their construction can be readily collected.

In the transference, to other alloy systems, of the methods used here for the indication of antimony content in lead, the difference in properties and reactions between the two systems must be carefully studied. Thus, in the new system, the rate of precipitation at room temperature may be too rapid for resistance measurements to be made, or the effect of variation in impurities on electrical resistance may be too great in comparison with the effect of the constituent whose concentration is being determined. Any obstacles occurring in these other systems, however, may possibly be overcome by some special procedure or treatment.

Rapid Control Method

By slight modification of the accurate method described above, it is estimated that the time elapsing from the sampling of a melt to the determination of its antimony content can be reduced to about 10 min. with little loss in precision. The cast alloy slug may be placed in a specially constructed miniature extrusion press, such as that shown in Fig. 3, and extruded into wire of a convenient size. The press should be maintained at some suitable and convenient temperature such as the eutectic temperature, 247 deg. C., by an oven arrangement, and the wire should be extruded and handled in a way to prevent unnecessary bending and working. A vessel of cold water should be placed beneath the extrusion press for quenching the wire as it is extruded. A length of the wire can then be cut off and placed in a groove on a conductivity measuring board designed so as to eliminate the necessity of bending the wire. The whole may then be placed in an ice-water bath for resistance measurement.

In this method, there is no necessity to heat treat the alloy to dissolve precipitated antimony, because experience has shown that, so long as the alloy is held at a temperature above 247 deg. C., the antimony has no chance to precipitate. The length and weight of the wires will be so closely determined by the dimensions of the extrusion die and of the conductivity board that variations can be neglected in calculations.

Conclusion

A method of correlating electrical resistance of certain types of alloys with their composition has been described. This correlation has been useful at the Bell Telephone Laboratories in the rapid, inexpensive, and accurate indication of antimony content of lead-antimony alloys. The authors wish to point out, however, that since fundamentally only the resistance of an unknown alloy is determined, this method can not be regarded as a method of analysis equivalent to a wet chemical method. They suggest, however, that this inexpensive and rapid electrical method may be advantageously substituted for many routine wet chemical analyses.

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MAGNESIUM - COBALT ALLOYS

By J. P. WETHERILL*

A SEARCH OF AVAILABLE literature on the physical properties of the binary alloys of magnesium indicates that those of cobalt have not been thoroughly investigated. No alloying action was found between cobalt and magnesium.[1, 2] Due to this lack of information, experiments were undertaken to determine some properties of alloys at the magnesium-rich end of the cobalt-magnesium system. Part of the data here reported has been cited in a U. S. Patent.[3]

Apparatus and Experimental Methods

Due to the difficulty in getting these metals to alloy they were heated for varying lengths of time at different temperatures and it was found that the percentage of cobalt was dependent on these two factors.

Charges of about 250 g. of metallic magnesium were placed in a cold-rolled steel crucible covered with the flux consisting[4] of:

Potassium chloride	32 g.
Magnesium chloride	91 g.
Sodium fluoride	11 g.

The furnace was then heated and maintained at a temperature above the melting point of magnesium. Metallic cobalt, obtained from the Belgo-American Trading Co., in the form of thin strips of electrolytically deposited 99.5 per cent cobalt, was introduced into the molten magnesium. After specified periods of heating, as shown in Table I, the resulting alloys were cast in a carbon mold so formed that a conical tit at the bottom could be used for cooling curves, while the 3-in. block above the cone could be sectioned to obtain specimens for analysis, the determination of specific gravity, hardness and microstructure.

The photomicrographs of specimens, etched in a 2 per cent alcoholic nitric acid solution, show an eutectiferous system similar to that of magnesium-copper and magnesium-nickel, substantiating the conclusions drawn from the freezing point data.

Table I.—Temperature in Degrees Centigrade at Definite Intervals After the Introduction of the Cobalt in the Formation of Alloys.

Alloy No.	Cobalt Introduced at Deg. C.	The Alloy Temperatures in Deg. C. at Consecutive Time Intervals 1 hr.	2 hr.	3 hr.	3.5 hr.	4 hr.	4.5 hr.	5 hr.	Pouring Temp.	Per cent Cobalt
9	650	730	700	...	...	...	...	...	700	0.73
13	800	850	850	850	850	850	...	...	700	3.91
14	700	700	790	820	845	870	840	810	745	4.60
15	730	830	850	895	910	920	...	...	750	4.70
16	850	850	850	950	990	1000	1040	...	800	4.79

Alloy 16 was heated to a maximum temperature of 1040 deg. C. The practical maximum temperature was 1120 deg. C., the boiling point of magnesium.

Specimen No. 13 was given a corrosion test by alternate immersion in a 3-per cent sodium chloride solution. This showed a corrosion rate of 250 mg. per sq. cm. per day, as compared to the corrosion rate of Dowmetal containing approximately 10 per cent aluminum and 0.2 per cent manganese, which is 10 mg. per sq. cm. per day. The hardness measurements given in Table III were made on a Rockwell type S hardness tester, using an ⅛-in. ball with a 60-kg. load.

Carbon crucibles[4] were used for melting the standard samples when checking the thermocouple, and a crucible especially supplied by the Norton Refractory Co., made from electrically fused magnesia, for the alloys. The cooling curve determinations were made with an alumel-chromel couple shielded in a porcelain tube 18 in. long, 3 mm. inside diameter, 5 mm. outside diameter, which in turn was protected from the metal by another carbon shield such as recommended,[5] and the E.M.F. generated was read on a potentiometer.

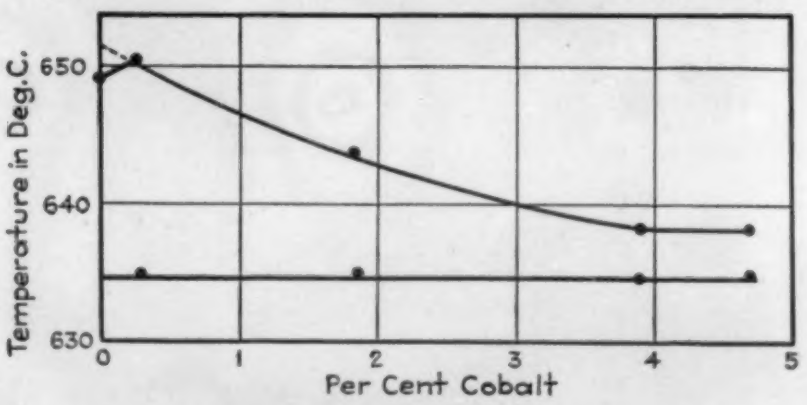
Table II.—Arrests on Cooling Curves and Density of These Alloys

Alloy No.	Analysis % Cobalt	Temperature at Which Crystallization Begins	Temperature at Which Crystallization Ends	Density Mg. C/Water 4 deg. C.
Mg.	...	649.3	....	1.737
7	0.31	650.5	635.5	1.741
10	1.84	643.8	635.1	1.764
13	3.91	638.2	634.7	1.787
14	4.60	Not determined	Not determined	1.809
15	4.70	638.5	635.7	1.810
16	4.79	Not determined	Not determined	1.808

Table III.—Hardness of the Alloys

Alloy No.	Rockwell B. Hardness ⅛" ball, 60 kg.	Percent Cobalt
Mg.	55.8	...
7	53.4	0.31
9	55.4	0.72
6	64.1	0.95
8	59.9	1.30
10	63.5	1.84
13	71.0	3.91
16	70.0	4.79

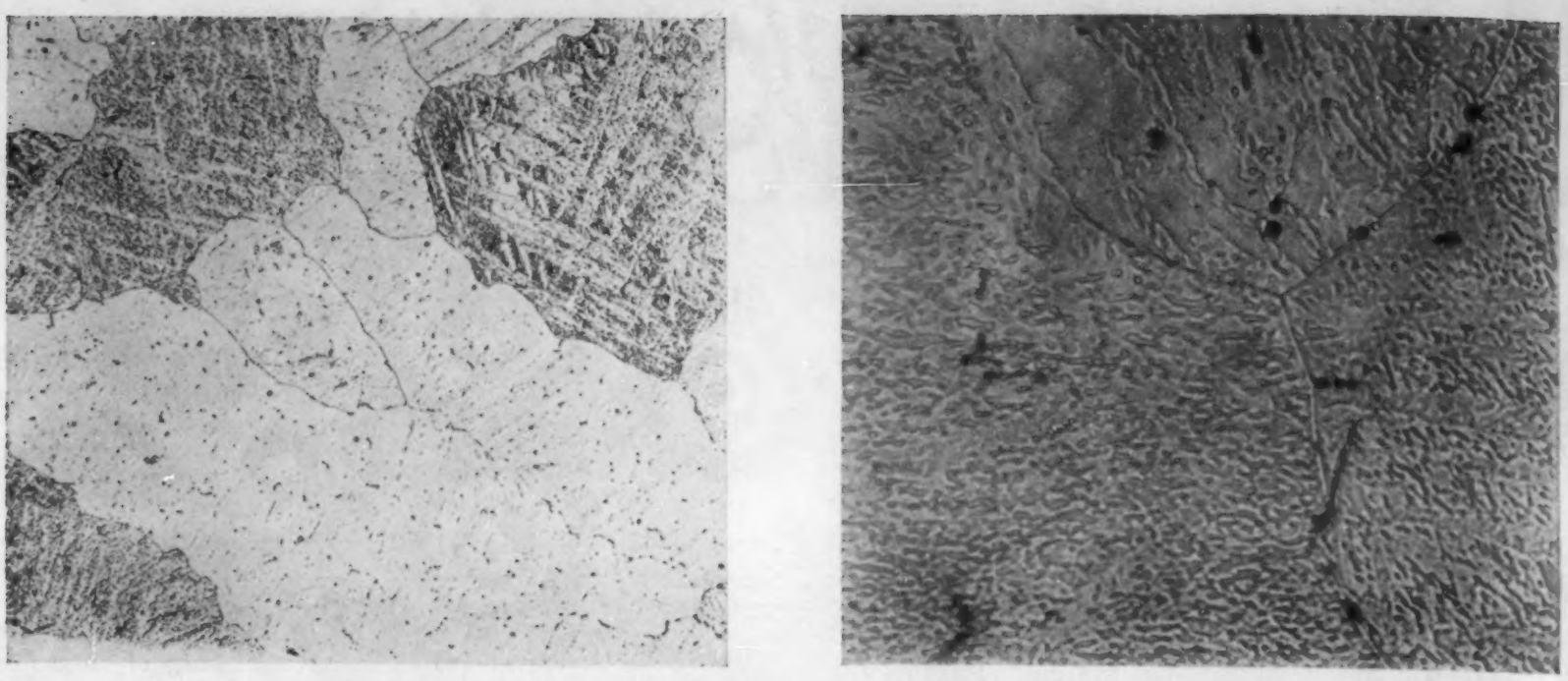
A resistance furnace, such as is recommended by the Bureau of Standards,[5] was used in obtaining the cooling curves. This furnace contained a pure nickel block of 2-in. round stock, 2 in. long, so situated that the top of the block came exactly at the center of the furnace. The junction of an alumel-chromel thermocouple was placed at the center of the block.



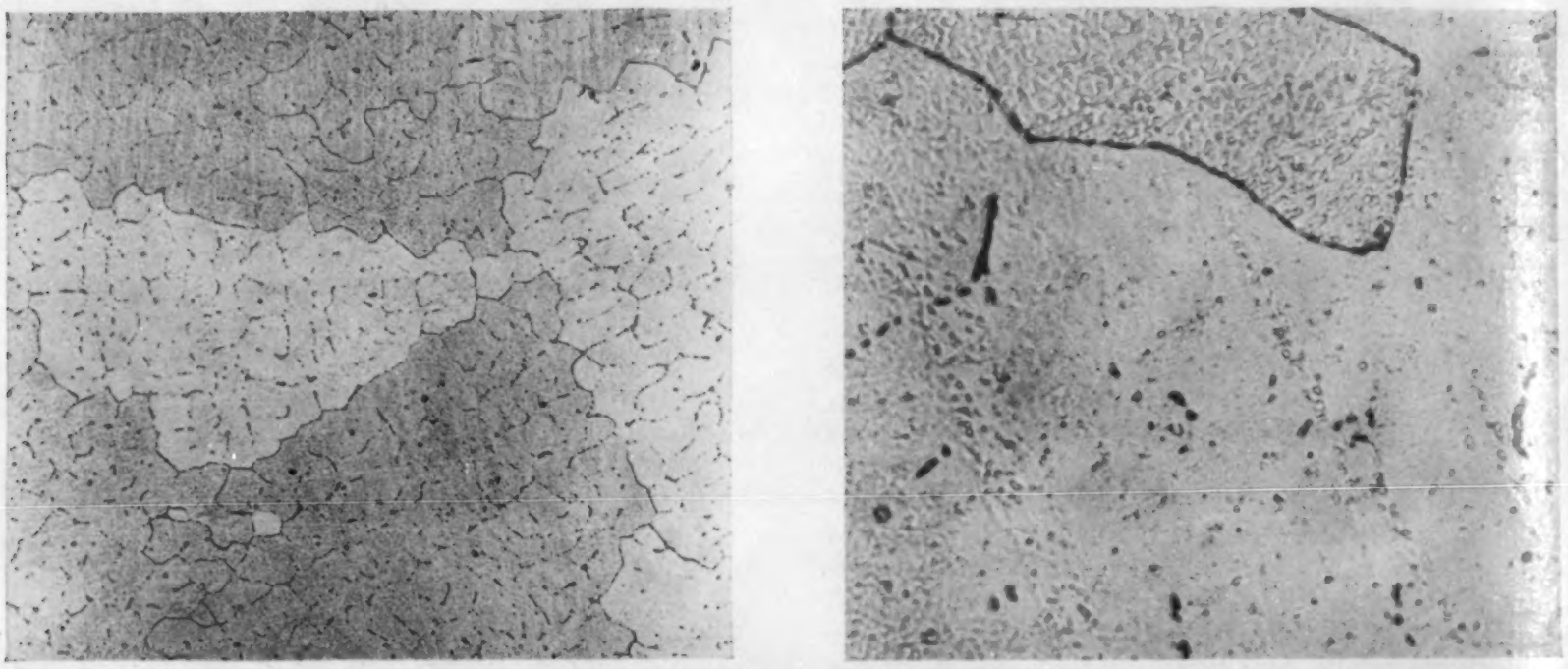
(Chart)—Arrests on Cooling Curve.

The couple in the melt was connected to the couple in the nickel block, so that alumel was in contact with

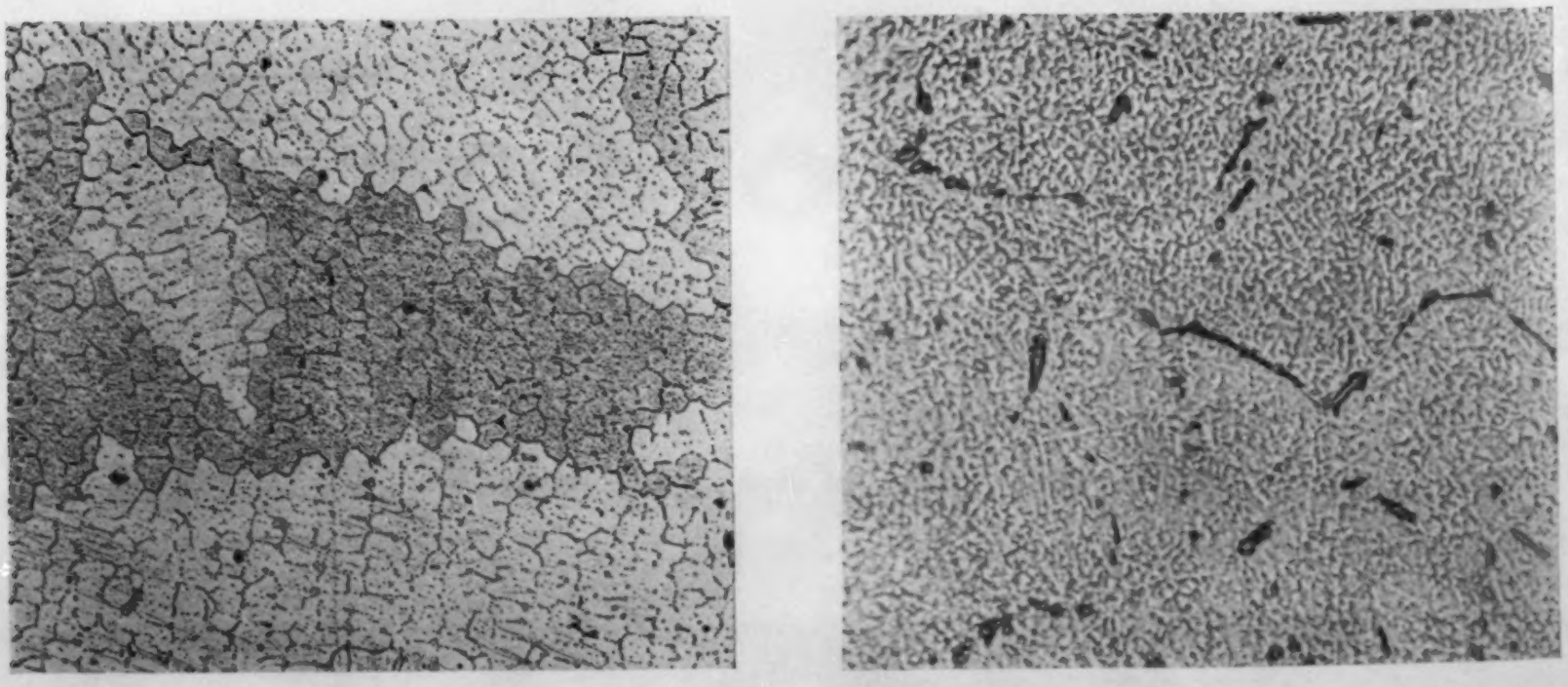
* Research Chemist, Washington, D. C.



Alloy No. 7 (0.31% Co) Some Porosity. Many fine black particles visible in the different grains. Large cast grains. Particles are also found in grain boundaries, and are probably Mg-Co compound. (7a, left, is 100 diameters; 7b, right, is 1000 diameters.)



Alloy No. 9 (0.72% Co) Very Large Grains. A fine network of lines exists in each grain. These lines are parallel to one another but vary in orientation from grain to grain. Probably dendritic segration. (9a, left, is 100 diameters; 9b, right, is 1000 diameters.)



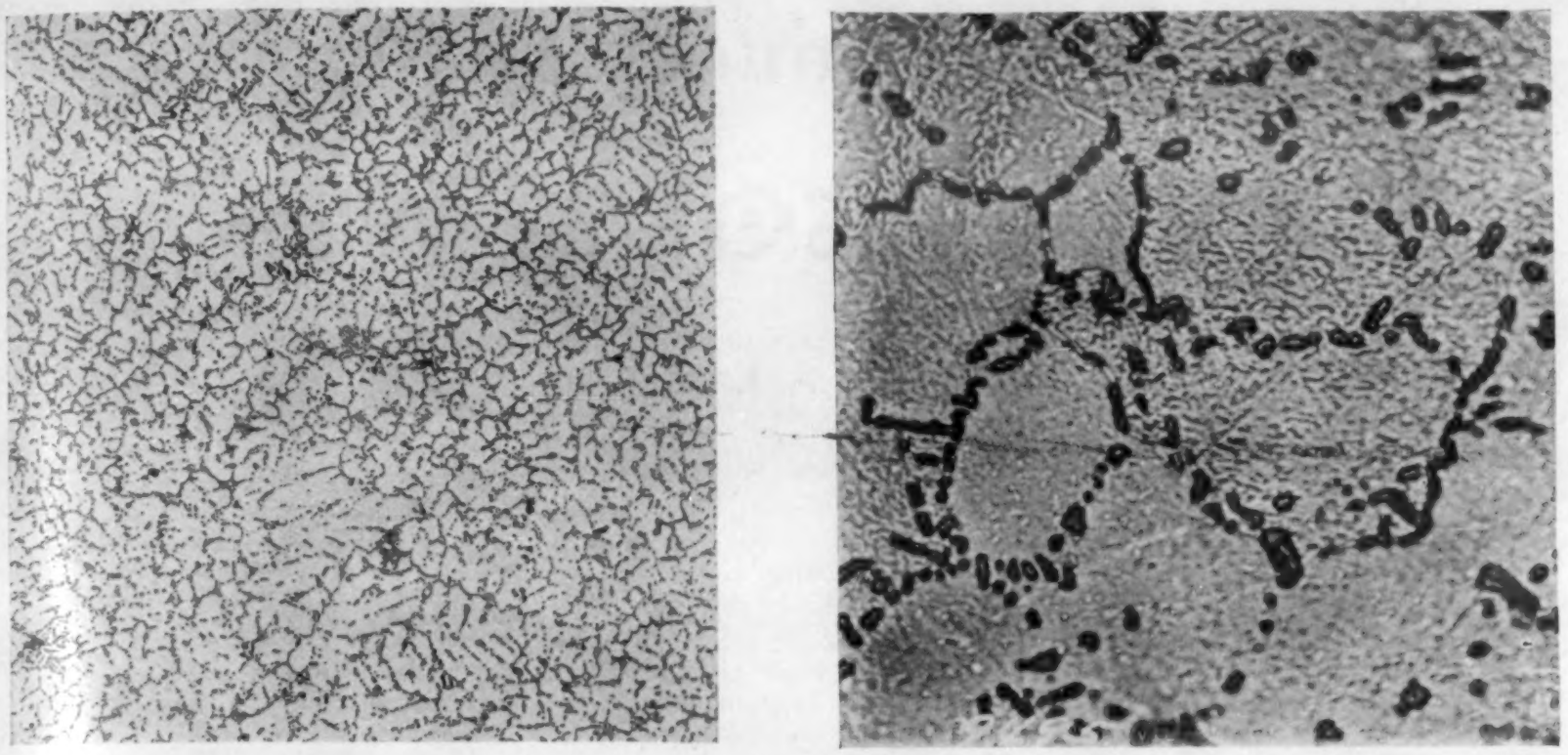
Alloy No. 10 (1.84% Co) Very Large Grains. A fine network of lines exist in each grain. As in No. 9 they are probably caused by dendritic segregation. (10a, left, is 100 diameters; 10b, right, is 1000 diameters.)

alumel and the two chromel leads were connected in series with a switch, a variable 100,000 ohms resistance, and a galvanometer. It was found that this hookup did not affect the reading on the potentiometer, and it gave a deflection on the galvanometer proportional to the difference in temperature between the block and the melt. In obtaining the cooling curve the "inverse rate" method was used and checked by the above differential method.

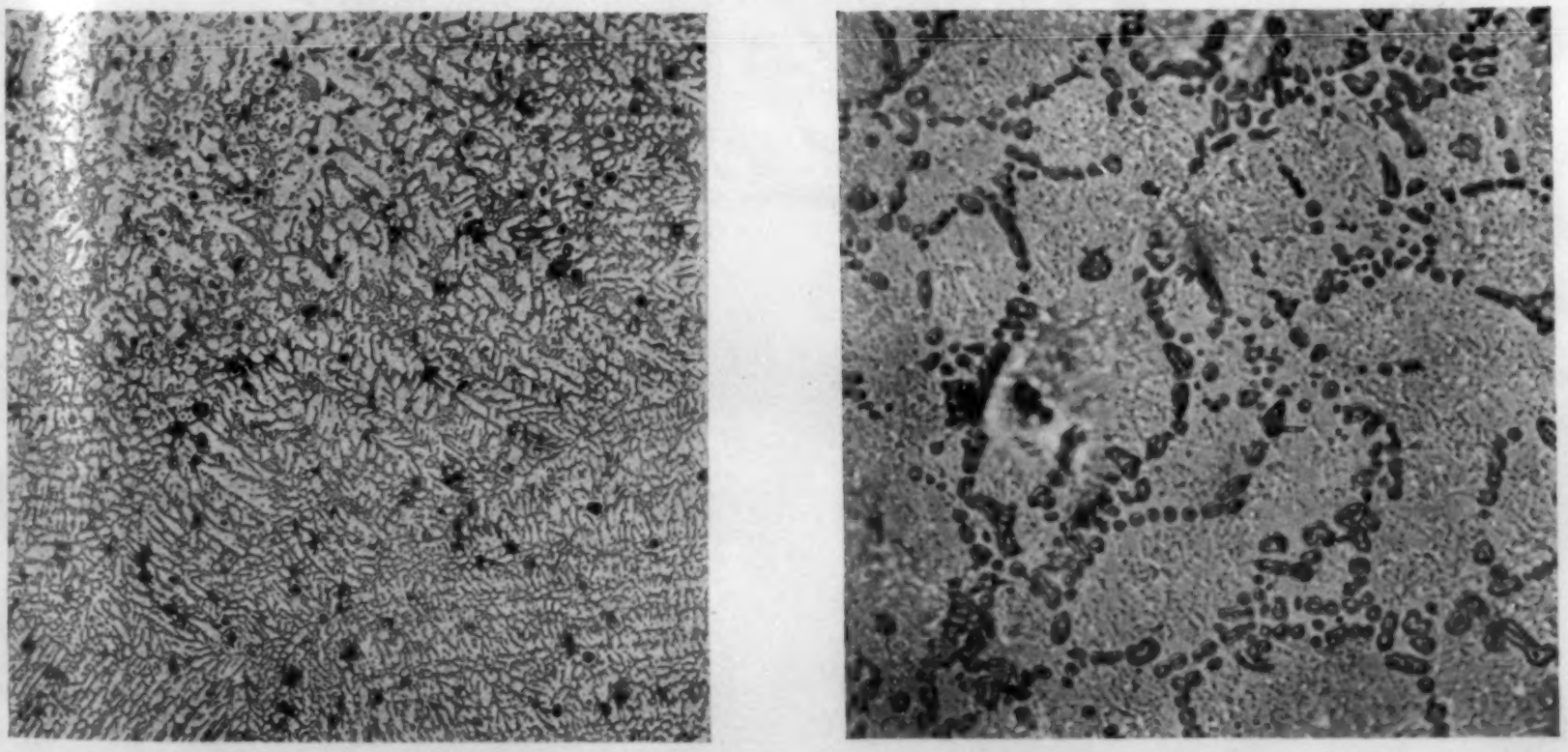
of A. W. Winston and F. L. Reynolds, of the Dow Chemical Co., in the work on microstructure.

Summary

A series of alloys of magnesium and cobalt were made containing a maximum of 4.79 per cent cobalt by weight. Specific gravity, freezing point, hardness, microstructure determinations were made. Extrapolation from the curve of composition versus freezing



Alloy No. 13 (3.91% Co) Grain Boundaries not very Obvious. Fine network has resolved itself into many small round particles. Structure similar to Mg-Cu (insoluble eutectic) alloys. (13a, left, is 100 diameters; 13b, right, is 1000 diameters.)



Alloy No. 16 (4.97% Co) Small Particles of Clear Mg Surrounded by Coarse Network of Round Particles. Grain size smaller than for No. 13. Some large particles, probably undissolved Co. (16a, left, is 100 diameters; 16b, right, is 1000 diameters.)

The thermocouple was standardized against a sample of aluminum of certified melting point obtained from the Bureau of Standards and checked every two or three runs. It will be seen from Table III and the chart that the alloy approaches a eutectic composition at approximately 5 per cent cobalt.

The author wishes to acknowledge the assistance

point indicated an eutectic point to lie at 635 deg. C. and approximately 5 per cent cobalt.

Bibliography

[1]*Journal* Chemical Society, Vol. 20, 1867, page 117.
[2]*Journal für praktische Chemie*, Vol. 101, 1867, page 375.
[3]U. S. Patent No. 1,880,614.
[4]Bureau of Standards Circular No. 346.
[5]Bureau of Standards Technological Paper No. 170.

Electrolytic Determination of Titanium, Zirconium or Aluminum in Chromium Steels and Alloys

By H. A. KAR*

To Our Readers

METALS & ALLOYS does not attempt to cover the field of analytical chemistry of metals since many text books give the standard methods and minor modifications are adequately recorded in current chemical journals. Now and then, however, an analytical advance bears so directly upon current metallurgical problems that it is fitting to bring it directly to the attention of the metallurgist.

Eighteen and eight (18:8) stabilized by titanium, has recently become of importance, thus the accurate control of titanium has become a pressing problem to the producer, and its accurate determination of importance to the user who wishes to be sure that the specified Ti : C ratio is maintained.

Nitriding steels of the aluminum type bring in an analytical problem also. The description of a special method applicable to such steel and ferroalloys appears to fall in the class that might well be made available direct to metallurgical readers. Another article by Mr. Kar setting forth a method for sulphur and 18:8, in high speed steel, etc., whose results indicate that previously accepted methods give too low results, is also scheduled for early publication.

We should appreciate readers' comments as to whether they want to see articles of this type in METALS & ALLOYS *or whether they prefer a diet solely of metallurgy.*

THE PRACTICE OF adding 0.5 to 3 per cent titanium or zirconium to "Enduro" and other high chromium alloys during the last few years has created a demand for a short and accurate method for determining the exact amount of these elements held in the steel. The methods described in all books are long and inadequate for producing dependable results, because of the difficulty of the complete removal of interfering elements such as chromium, nickel, iron, etc., and also because of loss of titanium or zirconium due to hydrolysis during preliminary operations.

In this laboratory we have adopted the electrolytic method and devised it to get away from all preliminary operations, and to obtain accurate results in less than 4 hr. By electrolysis the interfering elements are deposited while titanium, zirconium and aluminum, if present are left in the solution.

Brief Description of the Set-Up

The mercury in this method is used as the cathode and the power is supplied by a 1/16-in. thick platinum wire sealed in a glass tubing. About ½ in. of the platinum wire is left outside the lower end of the sealed glass tube to be dipped in the mercury from the side of the beaker and about 2 in. above the upper end of the glass tubing to be connected to the negative pole of the circuit.

A platinum plate, about 1¼ in. in diameter, welded to a ⅛-in. thick platinum wire and sealed in a glass tube, is used as the anode. The anode is connected to the positive pole of the circuit, and lowered about ½ in. below the surface of the solution. The plate is provided with a hole about ⅜ in. diameter in the center for the stirring rod.

The mercury is constantly agitated during electrolysis by a "T" shaped glass rod passing through the hole in the plate and attached to a motor driven stirrer. The "T" end of the rod reaches the bottom of the mercury and is adjusted to operate without touching the beaker or electrodes.

Procedure

Transfer one gram sample (two grams if titanium is less than 0.5 per cent) to a 200 c.c. beaker, add 20 to

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40 c.c. of 10 per cent sulphuric acid, and heat slowly until action is complete. Filter into a 200 c.c. tall electrolytic beaker containing mercury about one inch deep, wash a few times with water, and reserve the paper. The filtrate and washing should not exceed 75 c.c. in volume.

Set the beaker containing the solution in a trough of circulating water and electrolyze at 4 amp. 1½ to 2 hr. As soon as electrolysis begins, transfer the reserve filter paper to a platinum crucible and ignite. Cool, add a little potassium bisulphate and fuse. Add 5 c.c. water and 3 drops of sulphuric acid in the crucible and heat to dissolve the melt. Cool and combine with the main solution.

At the end of a set period, withdraw a drop of the electrolyte and treat with a drop of fresh 1 per cent solution of potassium ferrocyanide; if a blue color does not develop, raise the electrodes above the surface of the electrolyte and wash with cold water. Shut off the power and get the beaker out of the water trough. Filter, wash about 5 times with cold ½ per cent sulphuric acid and proceed with the filtrate by either of the following two methods.

1. Add enough sulphuric acid to the filtrate to make it 10 per cent acid by volume, cool and treat slowly with 6 per cent solution of cupferron while stirring, until further addition does not cause a precipitate. Allow this to settle for 5 min. Filter on suction and wash 5 times with 10 per cent cold hydrochloric acid and 10 times with cold water. Transfer the paper to a platinum crucible, dry and ignite. Volatilize the silica with hydrofluoric acid in the presence of sulphuric acid and again ignite at 1000 deg. C. in an electric muffle for one-half hour. Cool and weigh.

2. Treat the filtrate with excess of ammonia, add a couple of crystals of ammonium persulphate and boil for 2 min. Add paper pulp in the beaker and stir. Filter and wash with ammoniacal hot water. Transfer the paper to a platinum crucible and ignite. Volatilize the silica with hydrofluoric and sulphuric acid and ignite at 1000 deg. C. in an electric muffle for ½ hr. Cool and weigh.

Fuse the residue left in the crucible with a little potassium bisulphate, cool the melt and dissolve in 20 c.c. of 20 per cent sulphuric acid. Transfer the solution to a 200 c.c. beaker, add 2 grams of citric acid, and stir to dissolve. Render the solution decidedly alkaline with ammonia and saturate for 5 min. with H_2S. Filter and wash 10 times with 5 per cent ammonium citrate saturated with ammonium sulphide. Transfer the paper to a crucible and ignite. Cool and weigh. The difference in weight is titanium or zirconium oxide. If titanium is sought multiply by 60, and if zirconium is sought multiply the weight of oxide by 73.9.

Application of the Method to Other Alloys

This method can be applied to all kinds of steel alloyed with titanium or zirconium.

Determination of aluminum in nitralloy or other aluminum alloy steels is made by this method, proceeding exactly as described above and precipitating aluminum by ammonia after iron, chromium and other interfering elements are deposited.

The determinations of titanium and zirconium in ferrotitanium and ferrozirconium are also made by this method, precipitating either one by cupferron after electrolysis is completed.

This procedure works well for uranium in steels, if vanadium is absent. Mercury does not deposit the vanadium as it does the iron, manganese, chromium, cobalt, nickel, molybdenum, tin and copper.

Remarks

This method can be put on a production basis by installing four stirrers and four sets of electrodes, at a total cost of $250. and working four samples at one time (finishing them all in 4 hr.)

The accuracy of the method has been checked against titanium sulphate, or oxide fused by potassium bisulphate added to the steel, as well as against standard nitralloy No. 106.

The mercury can be cleaned and used again after every determination by shaking it in a separatory funnel with either concentrated hydrochloric acid or pressing through a chamois skin.

Courtesy Aluminum Co. of America

An X-Ray Study of Lüders' Lines and Strain Figures in Low Carbon Steel

By ROBERT F. MEHL* and M. GENSAMER †

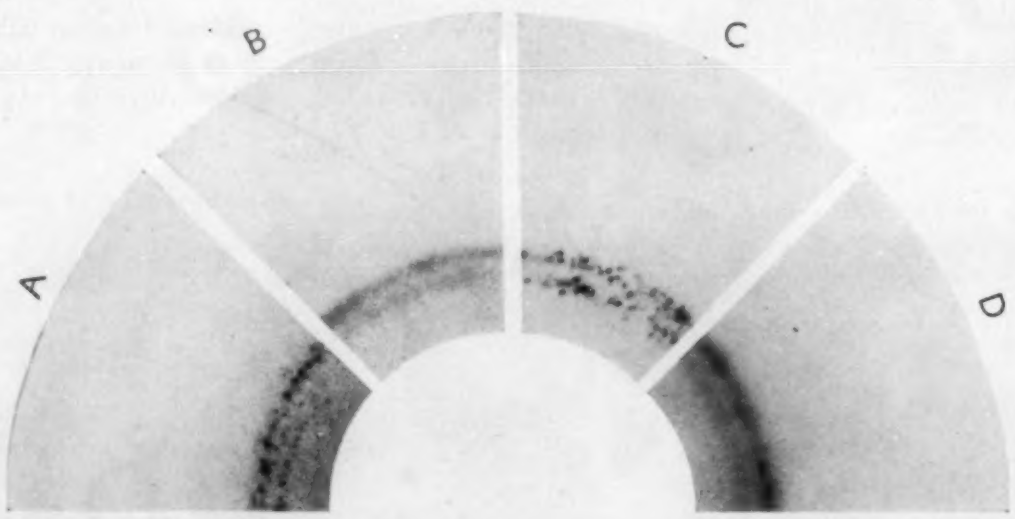
IRON AND STEEL DIFFER from most metals and alloys in the manner in which plastic deformation is initiated; the yield point is sharply defined and is accompanied by a marked elongation at constant load. This behavior is characteristic of annealed steel but not of freshly cold-worked steel. In the latter case the elastic range is very restricted, the yield point is ill-defined, and in no portion of the stress-strain curve may an elongation at constant load be found. Aging of cold-worked steel is usually accompanied by a return of the behavior characteristic of annealed steels.

The type of yielding characteristic of annealed steels leads to the formation of Lüders' lines ("stretcher-strains" in the deep-drawing trade), which are easily visible on the polished surface of low carbon steel, and of strain figures in the body of the metal revealed by the Fry etching technique; these strain markings are identical in nature. Each Lüders' line and each strain marking delineates a portion of the steel which has suffered the full extent of the elongation at the yield point; as yielding progresses these areas grow and finally include the whole piece, at which point the gross yield point elongation is complete and further deformation occurs by uniform elongation in each portion of the piece. The amount of elongation at the yield point generally varies between 1 and 2 per cent.

Regler's[1] studies of the peripheral widening of X-ray diffraction spots obtained with characteristic radiation by back reflection from deformed iron and steel led him to draw a continuous curve of the peripheral width against deformation. The deformation range represented includes the yield point. Because of the discontinuous method of yielding, it might well be expected that the curve of peripheral width would show a discontinuity at the yield point, but Regler's X-ray technique probably resulted in the inclusion in a single photogram of diffraction spots from both elastically and plastically deformed areas, and this together with his method of averaging the peripheral widths of many diffraction spots doubtless smoothed out the curve at this point.

Fell[2], apparently using small angle reflections from an X-ray beam at grazing incidence, obtained discrete spots on the {211} and {210} Debye rings from unstrained steel, with fair resolution of the doublet, and then demonstrated that areas including strain figures gave spots sufficiently widened peripherally as to overlap and to form continuous Debye rings, with complete loss in doublet resolution. Fell's sample was massive, with the strain figures developed in the usual way by the Fry etching technique.

Rawdon[3] prepared transmission Laue photograms of a mild steel strip in both strained and unstrained areas (as judged by Lüders' lines on polished surfaces) and was unable to detect any difference in these photograms, concluding that "the degree of deformation in the strain lines was not great enough to affect



X-ray Photograms Obtained by Back Reflection Using CoK_α and K_β. The Debye rings shown are from the {310} planes in α Fe. A is for unstrained material in a sample with Lüders' lines, B for material within a Lüders' line; C is for unstrained material in a sample with strain figures; D is for material within a strain figure area.

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† Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa.

[1] See review of Regler's several papers. C. S. Barrett. "Internal Stresses," *Metals & Alloys*, Vol. 5, 1934, June, page 131, July, page 154, August, page 170, September, page 196, October, page 224.

[2] E. W. Fell, Iron and Steel Institute, Carnegie Scholarship Memoirs, Vol. 16, 1927, page 101.

[3] H. S. Rawdon, Bureau of Standards *Journal of Research*, Vol. 1, 1928, page 467.

the X-ray pattern at least when the examination is carried out by the Laue method." It is to be noted that Rawdon used a steel bearing 0.23 per cent carbon, and that his sample was only 0.0025 in. thick,—the grain size shown in the photomicrographs proves that the strip sample was on the average only two grains thick. This contradiction in results, and the importance of information concerning yielding phenomena in steel, led to the present study.

It has been generally found that peripheral widening of spots in a monochromatic photogram—which is equivalent to asterism in a Laue photogram—is much more sensitive than radial widening of Debye rings (the alternative X-ray method) for low degrees of strain*, and peripheral widening was thus adopted for this work. The back reflection method[1] was used chiefly because it does not require laborious specimen preparation; the high resolution of this method is of no importance when peripheral widening of spots alone is studied though it does contribute to doublet resolution. The method does not differ markedly in principle from the methods used by Fell and by Rawdon. Cobalt radiation, generally used in the study of iron by the back reflection method, was employed, and photograms prepared on the {310} Debye rings with both specimen and photographic plate stationary.

Lüders' lines were studied in a specimen of standard automobile sheet steel (0.08% C), 0.0345 in. thick, courteously furnished by J. Winlock of the Edward G. Budd Mfg. Co., and strain figures were studied in a specimen of Bessemer steel (0.10% C) which had been strained in compression and then etched with Fry's agent. In both cases the strain markings were clearly defined.

The illustration shows the photograms prepared from these two samples. It may be seen that the unstrained steel in both cases gave Debye rings made up of sharply discrete spots, and that the strained iron gave Debye rings of nearly uniform intensity, with the doublet resolved in each case.

Similar studies were performed on a deep drawn article made of standard automobile sheet steel which showed profuse stretcher-strains. Following usual practice, this steel has been prestrained (by a cold pass, or by roller-leveling or stretcher-leveling) to avoid formation of stretcher-strains on subsequent drawing; the formation of stretcher-strains is evidence either for inadequate prestraining or for intervening aging. The prestraining treatment, however, deformed the iron lattice to such an extent that areas outside the stretcher-strains gave continuous Debye rings, indistinguishable from those obtained from areas within the stretcher-strains.

It is clear, therefore, that the X-ray method used is sufficiently sensitive to detect the internal strains which accompany the formation of Lüders' lines or strain figures in annealed iron and steel. The reasons for Rawdon's failure to observe peripheral widening are not clear, though it should be noted that the grains in Rawdon's very thin steel strip deformed with much less constraint from neighboring grains than in the steels used here.

Summary

The formation of Lüders' lines or stretcher-strains and of strain figures in annealed low carbon steels is accompanied by a distortion which may be readily demonstrated by the peripheral widening of X-ray diffraction spots obtained by back reflection with film and specimen stationary. In both cases the CoKα and Kβ Debye lines from the {310} ferrite planes are resolved. Strain markings in prestrained steel, however, cannot be detected in this way.

* This is clearly evident in the results of an X-ray study of the fatigue process now current in this laboratory.

A Hardness Conversion Chart

A HARDNESS conversion chart which may prove useful is herewith reproduced. It has been compiled by T. N. Holden, 1219 Glenwood Road, Brooklyn, N. Y., secretary-treasurer of the New York chapter of the American Society for Metals. It is similar to a table published by Mr. Holden a few years ago except that the Monotron Scale has been added.

"B" SCALE 1/16" Ball, 100 KGM	Rockwell Diamond "C" Scale 150 kgm	100 kgm	60 kgm	Brinell 10 m/m Ball 3000 kgm Load Dia. of Ball in m/m	Hardness No.	Tensile Strength, Equiv. 1000 lb. sq. in.	Scleroscope Uni. Ham.	Diamond Ball Brinell	Monotron ¼ m/m Ball Depth 9/5000 in.
		72	82	89	2.20	782	383	107	1220	130
		69	80	87	2.25	744	365	100	1114	120
		67	78	85	2.30	713	350	96	1021	110
		65	76	84	2.35	683	334	92	940	101
		63	74	83	2.40	652	318	88	867	93
		61	72	82	2.45	627	307	85	803	86
		59	71	81	2.50	600	294	81	746	80
		58	69	80	2.55	578	282	76	694	74
		56	68	79	2.60	555	271	75	649	70
		54	67	78	2.65	532	260	72	606	66
		52	65	77	2.70	512	251	70	587	63
		51	64	76	2.75	495	242	68	551	60
		49	63	76	2.80	477	233	66	534	57
		48	62	75	2.85	460	226	64	502	54
		47	61	74	2.90	444	217	61	474	51
		45	60	73	2.95	430	210	59	460	49
		44	59	73	3.00	418	205	57	435	47
		43	58	72	3.05	402	197	55	423	46
		41	57	71	3.10	387	189	53	401	44
		40	56	71	3.15	375	183	52	390	42
		39	55	70	3.20	364	178	50	380	41
		38	54	69	3.25	351	172	49	361	39
		37	53	69	3.30	340	167	47	344	37
		36	52	68	3.35	332	162	46	335	36
		35	52	68	3.40	321	157	45	320	35
		34	51	67	3.45	311	152	44	312	34
		33	50	67	3.50	302	148	42	305	33
		31	49	66	3.55	293	144	41	291	32
		30	49	66	3.60	286	140	40	285	31
		29	48	65	3.65	277	136	39	278	30
		28	47	65	3.70	269	132	38	272	29
		27	46	64	3.75	262	128	37	261	28
		26	45	64	3.80	255	125	36	255	27
		25	45	63	3.85	248	121	36	250	27
100		24	44	63	3.90	241	118	35	240	26
99		23	43	62	3.95	235	115	34	235	25
98		22	42	62	4.00	228	113	33	226	24
97		21	41	61	4.05	223	109	33	221	23
97		20	41	61	4.10	217	106	32	217	22
96		19	40	60	4.15	212	104	31	213	22
95		18	39	60	4.20	207	101	30	209	22
94			38	59	4.25	202	99	30	201	21
93			37	58	4.30	196	96	29	197	21
92			36	58	4.35	192	94	29	190	20
91			35	57	4.40	187	91	28	186	20
89			34	56	4.45	183	90	28	183	19

J. J. Crowe New President of A.W.S.

John J. Crowe was elected to the presidency of the American Welding Society at its annual meeting in New York in April. The society has elevated to this office a man who is well known not only in welding circles but also in the activities of other technical societies. He has a keen appreciation of the problems of the A. W. S., having been senior vice-president since 1933. He was a director of the society for 10 years, from 1924 to 1934. He served two terms, 1920 to 1921 and 1923 to 1924, as chairman of the Philadelphia Chapter of the American Society for Metals, then the A.S.S.T., and was chairman of the New York Chapter of the A.S.M. from 1932 to 1933. Mr. Crowe was educated in the high schools of Washington and at the George Washington University. After several years' experience at the U. S. Bureau of Standards, at the various U. S. Navy Yards and in other capacities, he became engineer in charge of apparatus research and development for the Air Reduction Co. with laboratories at Jersey City, which position he now holds.

Recent Progress in Steel Making Reported from Germany—II

A Correlated Abstract

By S. EPSTEIN*

THE FIRST INSTALLMENT of this valuable series by Mr. Epstein, published in the May issue, dealt with "Equilibria between Slag and Bath." The present one, the second, discusses "Gases in Steel." These will be followed by others on desulphurization, defects in steel and some recent practical developments.

GASES IN STEEL

GASES in steel have received a good deal of discussion in Germany recently, and Schenck[4] has contributed a very good summary of the subject. Gas evolution, mainly of CO, makes possible the production of rimming steel; however, such a large proportion of hydrogen accompanies the evolution of CO that consideration of the effect of H can hardly be neglected in a study of the rimming action. In killed steel the H cannot be swept out along with the CO, as in rimming steel, and may remain in the steel. It has been suggested that the presence of such dissolved H may harmfully affect the properties of steel and may be a contributory cause of such defects as flake. The presence of nitrogen is now recognized as an important cause of aging in steel.

Hydrogen in Steel

Most of the following material is given in Schenck's book[4]. Figs. 7 and 8 show the solubility of H in Fe, Ni, Cr, and Mn at temperatures up to 1200 deg. C. It will be noted that the solubility of H in Ni is somewhat greater than that in Fe, whereas the solubility of H in Cr is somewhat less than in Fe. The solubility of H in Mn is much greater than Fe—about three times as great at 1000 deg. C. and about six times as great at 1200 deg. C. Pourcel[6] observed as long ago as in 1882 that the H content of killed steels increased with the Mn content; the reason probably lies in the higher solubility of H in Mn and in ferromanganese.

Fig. 9 gives an interesting series of curves showing the relative amounts of the gases CO, CO_2, H, and N evolved from rimming, semi-killed, and killed ingots of basic open-hearth steel during solidification. The weight of the ingots was 1400 lb.

In the rimming steel the gases evolved immediately after pouring consisted of about equal proportions of CO and N. As solidification began and a vigorous rimming action ensued, the proportion of CO gas increased until it composed 80 per cent of the total gas evolved. The proportion of H given off, small at first, increased slowly as the rimming action got under way, and then increased more sharply as the rimming action subsided; finally the proportion of H equaled that of CO. The proportion of N decreased fairly rapidly to a low value.

In the semi-killed steel, there being less CO evolved, the proportion of N was considerably larger than that of CO at the beginning; the proportion of N then decreased with time. Of most interest is the fact that here the proportion of H increased as time went on, until it composed over half the gas given off.

In the killed steel almost no CO gas was given off after pouring was completed, the gases evolved being

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mostly N and H. Since the proportion of N dropped off fairly sharply with time, that of H rose equally sharply until it composed about 90 per cent of the gases evolved. The steel was killed with Si and Al. Evidently neither of these deoxidizers has the effect of "fixing" H in the way that Al or Ti may fix N, for example.

Fig. 10 shows both the proportion and amount of gas sucked off by means of vacuum from 175-lb. ingots of Bessemer and basic electric steel during solidification. Very much the same picture is given as in the previous curves, the outstanding points being the large

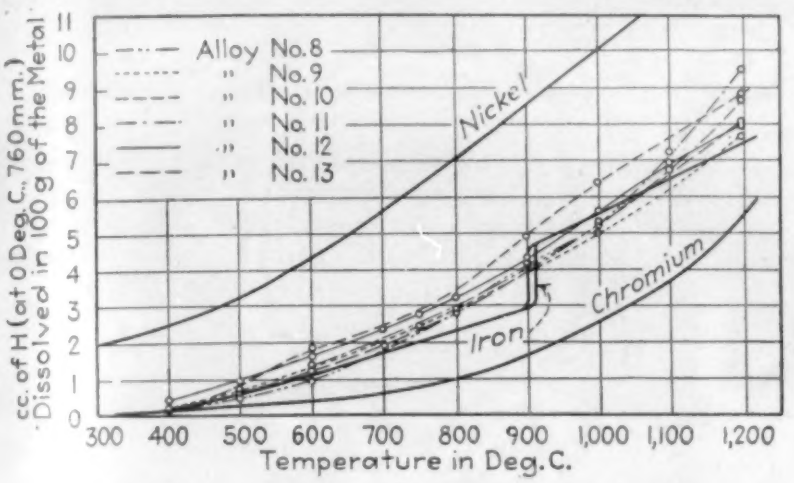


Fig. 7.—Solubility of Hydrogen in Different Fe-Ni-Cr Alloys with Rising Temperature. Luckemeyer-Hasse and Schenck.[5] Composition of Alloys—Per Cent:

Alloy No.	C	Ni	Cr
8	0.01	20.3	9.6
9	0.01	15.1	14.6
10	0.01	10.0	29.5
11	0.02	2.04	44.1
12	0.02	5.1	44.2
13*	0.05	9.02	17.5

*also 0.93% Si and 0.45% Mn

proportion of H given off by the steel and the fact that the H is evolved not early in the solidification period but later, so that some H is probably entrapped in the solidified steel.

The amounts of gases drawn off from acid open-hearth, basic electric, and Bessemer steel, as determined by Améen and Willners are shown in Table I. Even in some of the lower C and Si steels, which gave off mostly CO, the amount of H drawn off constituted a large proportion of the total amount of gas. In the

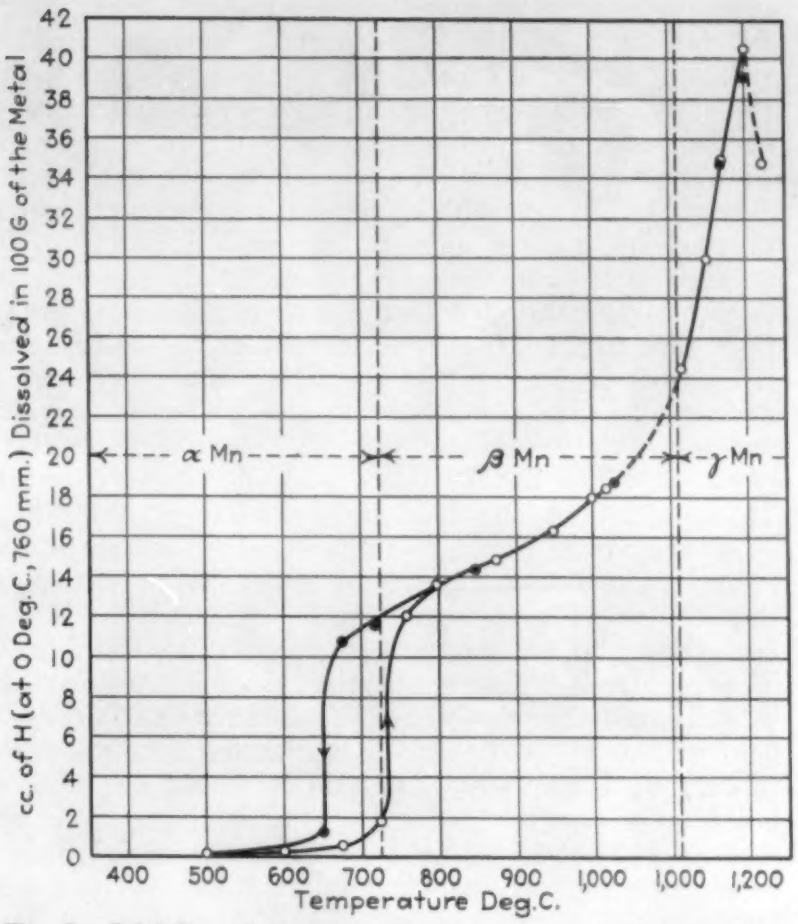


Fig. 8.—Solubility of Hydrogen in Manganese. Luckemeyer-Hasse and Schenck.[5]

higher C killed steel the total amount of H drawn off was about equal to the CO; as stated previously, however, most of the CO came off shortly after pouring, whereas most of the H was drawn off later.

Obviously, the data described above are not of a very high order of accuracy; nevertheless, they are at least approximately correct, and similar results have been obtained by several investigators. There appears to be no doubt that large enough proportions of H gas are given off from steel during solidification to affect the rimming action and to play a part in causing blowholes and possibly other discontinuities in steel.

Hydrogen in Solid Steel

The H which tends to come off from molten steel can easily escape; during solidification it may be entrapped, however, and form blowholes or possibly in-

TABLE I. GASES DRAWN OFF BY SOLIDIFYING STEEL

Améen and Willners[5]

Type of Steel	Composition, Per Cent C	Mn	Si	Cr	Tapping Temperature, Deg. C.	Amount of Gas, cc. per kg. Steel CO	CO_2	H_2	N_2
Acid Open-Hearth Steel									
C steel	0.88	0.36	0.19	....	1485	54	20	30	....
C steel	1.44	0.42	0.21	....	....	(122)	(1.9)	(114)	.... (1)
Cr steel	0.93	0.38	0.22	0.10	....	66	3.6	54	....
Cr steel	1.01	0.39	0.24	0.62	....	(121)	(31)	(109)	.... (1)
Cr-V steel	0.50	0.60	0.20	0.95	1445	176	5.6	87	....
				0.15 V	1465	204	10	149	....
Cr-V steel	0.49	0.59	0.16	0.86					
				0.18 V					
Basic Electric Steel									
C steel	0.10	0.11	0.02	....	....	394	43.0	.....	24.1 (2)
C steel	0.10	0.42	0.05	....	....	182	5.0	32	....
C steel	0.10	0.53	0.02	....	....	304	18.4	79	....
C steel	0.12	0.70	0.05	....	....	142	10.7	65	....
Mn steel	1.00	11.85	0.23	....	....	26	1.4	51	....
Cr steel	0.35	0.43	0.38	13.97	....	80	5.1	86	....
				0.47 Ni					
Cr steel	0.99	0.30	0.27	0.50	....	27	1.6	29	....
Cr steel	0.98	0.32	0.23	0.41	....	135	8.7	133	....
Bessemer Steel									
C steel	0.02	0.10	0.004	....	....	396	25.1	175	....
C steel	0.09	0.10	0.002	....	....	318	13.1	39	....
C steel	0.57	0.23	0.023	....	....	159	10.9	144	....
C steel	0.77	0.24	0.023	....	....	134	10.2	85	....
C steel	0.77	0.24	0.042	....	....	384	13.0	388	....
C steel	0.85	0.23	0.024	....	....	72	1.9	25	....
C steel	0.93	0.31	0.0207	....	....	184	23.1	153	....

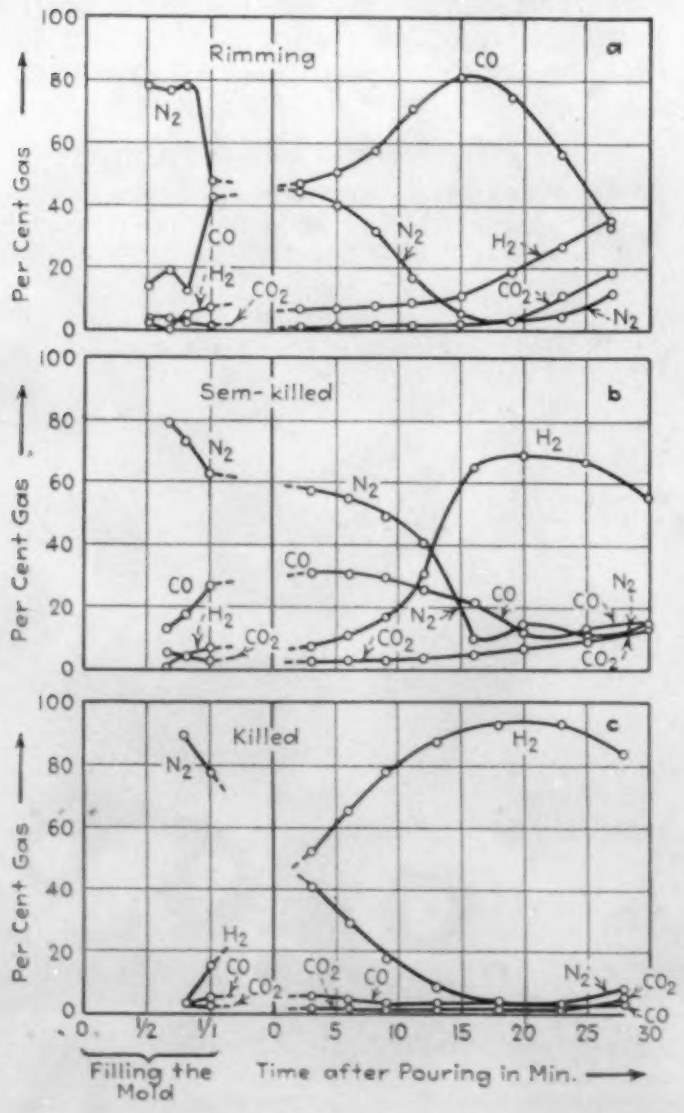
(1) Weight of ingot not certaiu. (2) Not deoxidized.

terstitial spaces between the dendrites[13]; after solidification most of the H is present in supersaturated solution, so that it builds up a solution pressure within the steel which may result in high internal stresses, as in the familiar H embrittlement after pickling. Fig. 11 indicates the solution pressure in soft steel of different H contents with change in temperature, as calculated by Luckemeyer-Hasse and Schenck[5]. The solution pressures were calculated for H contents between 0.001-0.003 per cent, which is somewhat higher than that usually found in soft steel, but still not entirely outside the range. The H content of a series of carburizing steels analyzed at the Bureau of Standards[9] ranged from "not detected" to 0.0001 to 0.004 per cent. For the 19 out of 27 specimens in which H was detected, the average H content was 0.0006.

As shown in Fig. 11, the solution pressure of dissolved H increases rapidly at lower temperatures, so that for an H content of 0.001 per cent it would become equal to the strength of the steel at 400 deg. C. This picture is highly qualitative, since it does not take into account the possibility that some of the H may be held in the space lattice in a manner corresponding to that of a compound, so that it would not tend to build up a solution pressure. Furthermore, it is not certain what the chemical or thermodynamic concept of solution pressure of a gas in a solid really means in terms of the strength of the solid. Apparently it does not follow, when the calculated thermodynamic solution pressure of H in steel exceeds the strength of the steel that the steel is necessarily disrupted. However, the diagram appears to give an indication of the harm

Fig. 9.—Composition of Gases Evolved from Steel during Pouring and Solidification. Klinger.[7]

Melt	C	Si	Mn	Remarks
a	0.08	Trace	0.35	Effervescent
b	0.10	Trace	0.45	Treated with Si and Al; not completely killed
c	0.10	0.15	0.44	Treated with Si and Al; completely killed



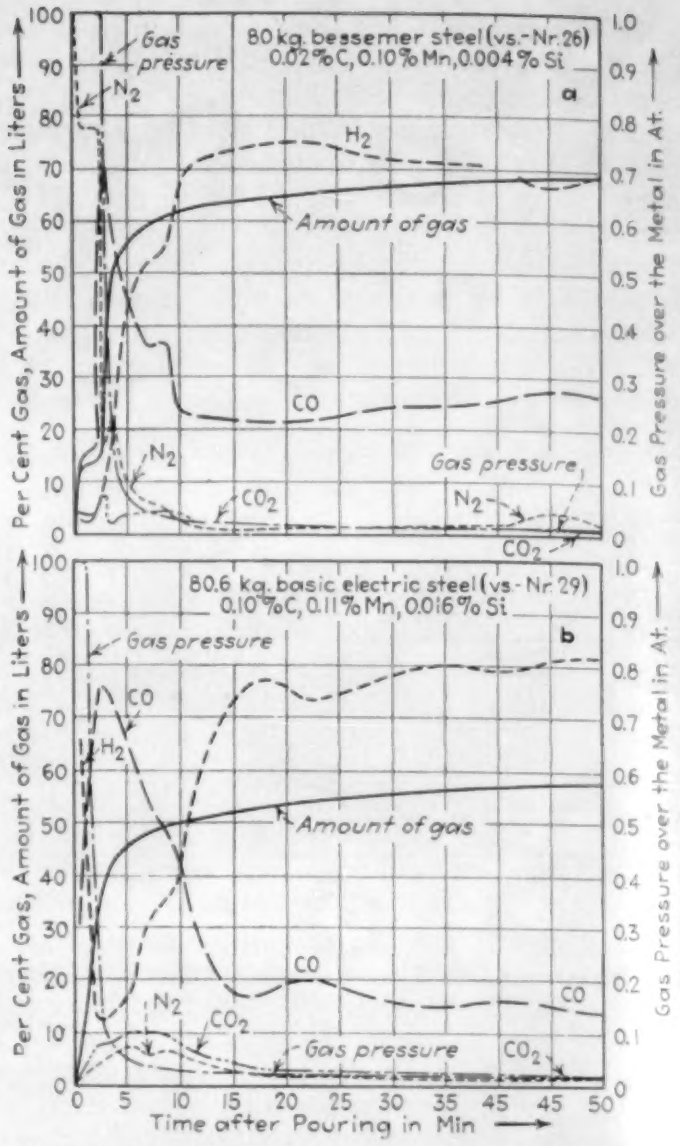

80 kg. bessemer steel (vs.-Nr. 26)
0.02% C, 0.10% Mn, 0.004% Si
80.6 kg. basic electric steel (vs.-Nr. 29)
0.10% C, 0.11% Mn, 0.016% Si
Gas pressure
Amount of gas
Per Cent Gas, Amount of Gas in Liters
Gas Pressure over the Metal in At.
Time after Pouring in Min

Fig. 10.—Composition and Amount of Gases Drawn Off from Unkilled Steel during Solidification. Ameen and Willners.[8]

H may possibly do in solid steel, particularly if during solidification the H is segregated between the dendrites.[13]

Fortunately H has a high diffusivity in steel so that its harmful effects may be overcome by annealing. Lewkonja and Baukloh[10] found that H diffuses along the grain boundaries, the rate of diffusion thus being greater in finer grained steels. Messkin and Margolin[11] observed that H may occur in Si transformer sheet in a more "stable" form in which it can only be removed by 4 to hr. annealing at 800 deg. C., and in an "unstable" form in which it can be removed by low temperature heating at 100 to 150 deg. C., which is well known to overcome pickling embrittlement.

The possible harmful effects of H in steel may be summarized as follows: The presence of an unusual amount of H may disturb our control of the rimming action, since Al or other deoxidizers have no effect upon it. H tends to be evolved later during solidification than other gases and hence would seem likely to form blowholes, or accumulate in the interstices between the dendrites. H does not form a stable solid compound with steel; its presence in solution, therefore, tends to set up internal stresses which increase in magnitude as the temperature falls. On the other hand, H has a high diffusivity in steel, so that annealing can remove or uniformly distribute it.

Sources and Elimination of Hydrogen

There being no "dehydrizer" in the sense that there are deoxidizers, efforts to minimize the harmful effects of H in steel must be bent to its elimination at the source. Bardenheuer[12] states that rust contains large amounts of H and that contamination with H

in the open-hearth may occur through the use of rusted scrap. Lime may contain appreciable moisture which may break down to H; burned lime particularly takes up moisture readily. H may also be absorbed from the fuel, but the most important source of H is probably moisture from the air; for this reason Herty[14] has mentioned the advisability of drying the air used for combustion both in the blast furnace and in the open-hearth.

A favorable time for the absorption of H from the moisture in the air would seem to be during the meltdown before a slag forms over the bath. A quiet slag low in FeO may be insufficient protection against H absorption from the furnace atmosphere; apparently a fluid reactive slag fairly high in FeO is necessary. An important function of a vigorous boil is to remove dissolved H from the bath; prolonging the boiling period by means of a higher C charge is also helpful. A bath with an insufficient boil, one which remains quiet a long time after the boil, or one with an insufficient slag coverage, may give rise to H blowholes or even to H effervescence.

Carbon Monoxide Gas

Although H no doubt plays an important part in the rimming action of effervescing steel, the evolution of CO is after all the chief cause. Schenck[4] does not agree with the view that CO evolution in a rimming ingot is induced by the "catalytic" effect of introducing a solid body or by the formation of solid nuclei of metal particles or inclusions as the metal begins to freeze. He believes the cause is rather that, as the temperature falls, the solubility of O decreases, so that FeO separates out and reacts simultaneously with the C to form CO. However, the greatest decrease in the solubility of O takes place as crystallization begins; the remaining liquid metal also becomes richer in FeO and C, so that at this time brisk evolution of CO ensues. CO evolution ceases as the amount of FeO or C diminishes. However, before CO can be given off, it must exert a pressure greater than that surrounding it. Thus CO evolution may be held back by the atmospheric pressure, by the ferrostatic pressure in the lower part of a deep ingot, or by capping an ingot.

If the steel contains some Mn and Si, not only is the amount of dissolved O lowered but also, as has been indicated in the discussion of the equilibria of Figs. 3 and 4, the O as it separates out does not form

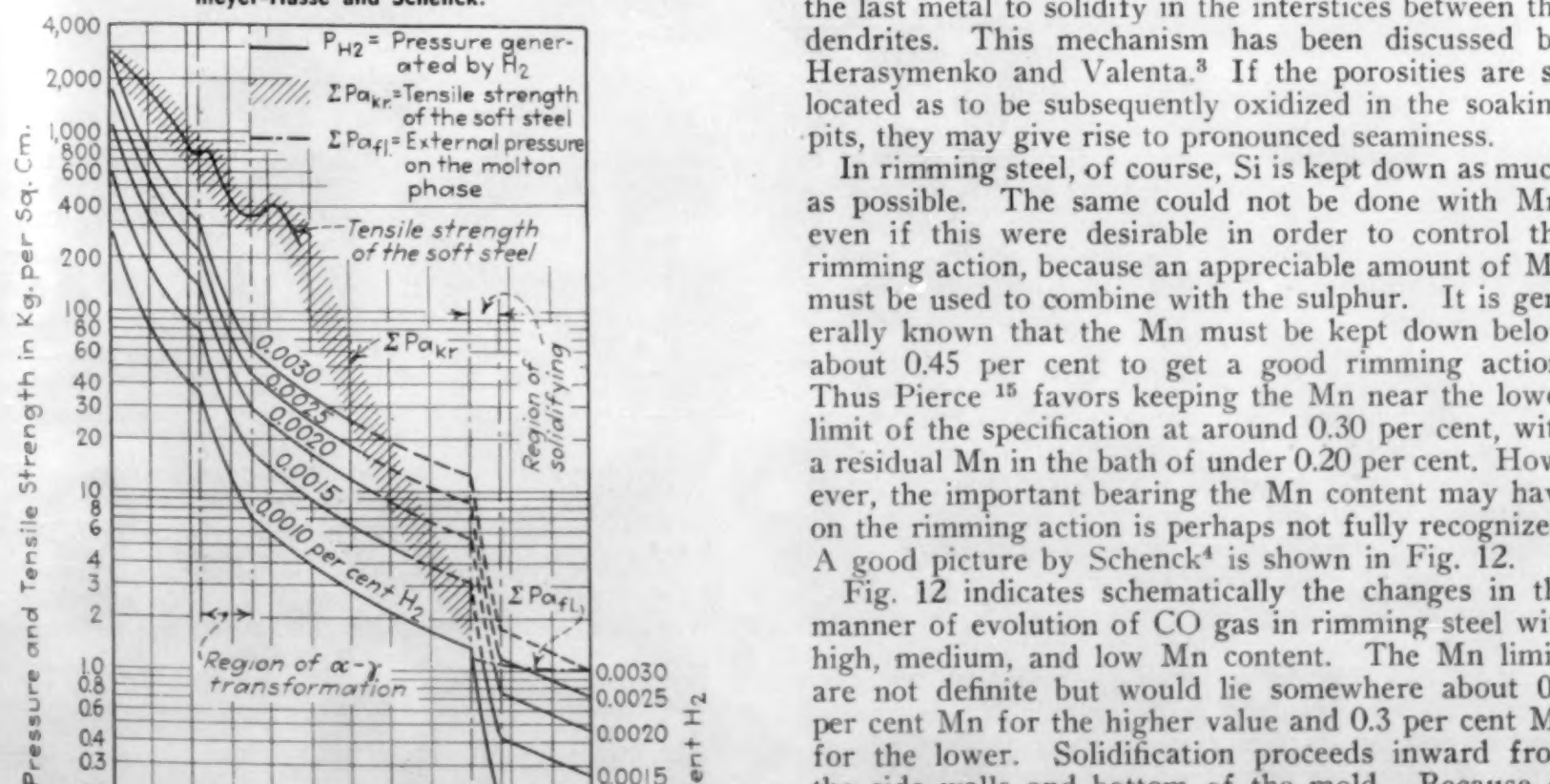


Fig. 12.—Effect of Various Manganese Contents on the Carbon Monoxide Evolved during the Solidification of an Effervescing 0.10 Per Cent C Steel. Schenck.[4]

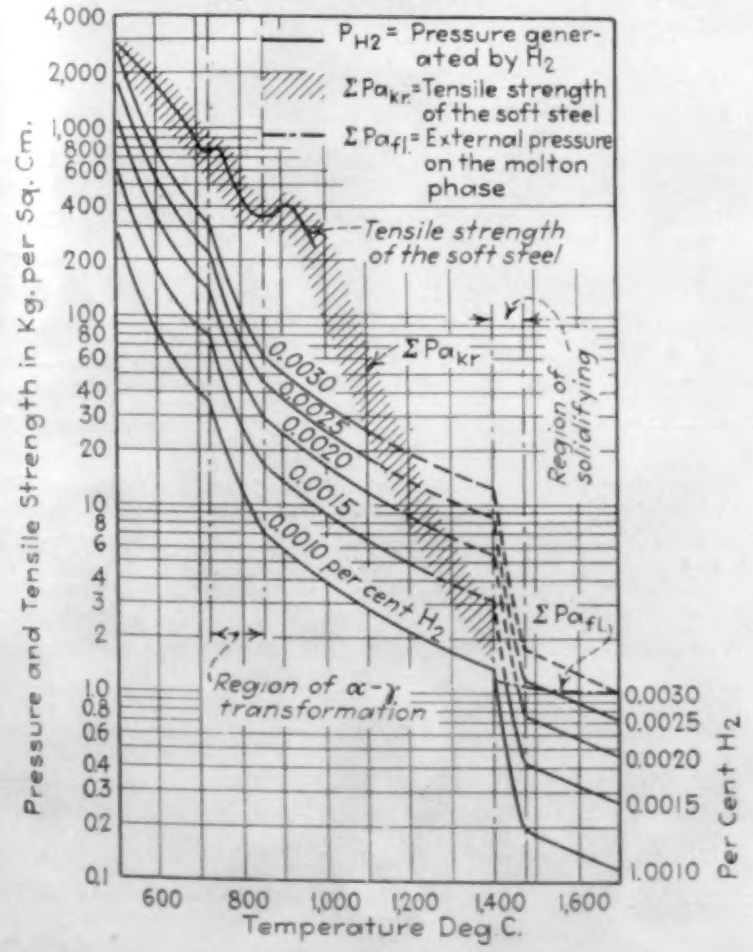
pure FeO but an FeO, MnO silicate. Although this is fluid, still it does not react so readily with C to form CO as does pure FeO. Thus, not enough CO may be produced to cause a good rimming action.

In killed and semi-killed steels, where an appreciable amount of Si is present in proportion to the Mn, solid silica may separate out. This will not react with C at all. The course of the Si isothermal (see Fig. 4) is such that even if solid SiO_2 separates out at first, fluid silicates may finally separate out as solidification proceeds, unless the Si content is maintained above the isothermal. The fluid silicates will then react with the C, generating CO which will cause sponginess in the last metal to solidify in the interstices between the dendrites. This mechanism has been discussed by Herasymenko and Valenta.[3] If the porosities are so located as to be subsequently oxidized in the soaking pits, they may give rise to pronounced seaminess.

In rimming steel, of course, Si is kept down as much as possible. The same could not be done with Mn, even if this were desirable in order to control the rimming action, because an appreciable amount of Mn must be used to combine with the sulphur. It is generally known that the Mn must be kept down below about 0.45 per cent to get a good rimming action. Thus Pierce [15] favors keeping the Mn near the lower limit of the specification at around 0.30 per cent, with a residual Mn in the bath of under 0.20 per cent. However, the important bearing the Mn content may have on the rimming action is perhaps not fully recognized. A good picture by Schenck[4] is shown in Fig. 12.

Fig. 12 indicates schematically the changes in the manner of evolution of CO gas in rimming steel with high, medium, and low Mn content. The Mn limits are not definite but would lie somewhere about 0.7 per cent Mn for the higher value and 0.3 per cent Mn for the lower. Solidification proceeds inward from the side walls and bottom of the mold. Because of the ferrostatic pressure, CO evolution is held back somewhat in the lower portion of the ingot. Thus, in region *a* crystallization proceeds without marked evolu-

Fig. 11.—Variation with Temperature of the Pressure Generated by Dissolved Hydrogen in Soft Steel. Calculated. Luckemeyer-Hasse and Schenck.[5]



tion of CO because of the higher ferrostatic pressure; this region naturally becomes wider toward the bottom of the ingot where the ferrostatic pressure is greater. In region *b* the pressure is lower, and besides the concentration of FeO and C is higher because of segregation as the metal freezes; in this region CO evolution is brisk; note that it widens at the top as the pressure is reduced. In region *c* there is a concentration of Mn because of segregation; as a result the O which separates out forms a solution of FeO-MnO rather high in MnO; as this does not react so readily with C to form CO as does pure FeO, CO evolution is diminished; note that this region becomes wider at the bottom where the pressure is greater.

Now with a low Mn content, there is no region *c*, and CO evolution is very brisk; with a high Mn content there is a large *c* region where CO evolution is very slow; this would be especially pronounced where appreciable Mn segregation occurs in the center of the ingot. Of course, whenever a big-end down ingot solidifies without enough gas evolution, either because of too early and brisk evolution resulting in a "shoed

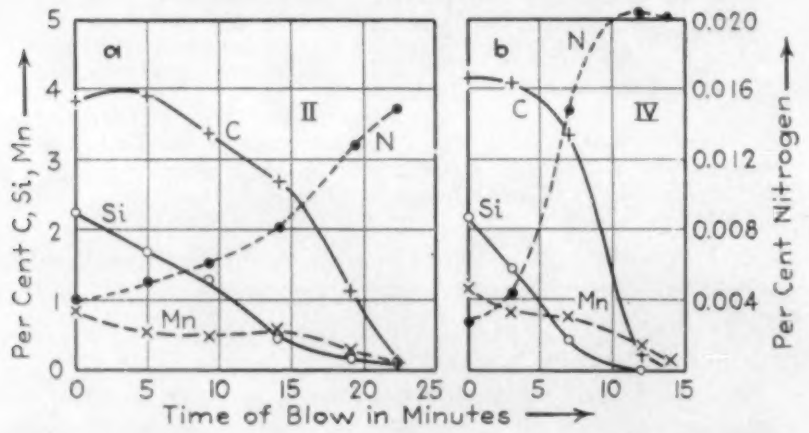


Fig. 13.—Nitrogen Absorption of Bessemer Steel. Svetchnikoff.[15]

in" ingot. or because of insufficient evolution as in region *c*, secondary piping may result near the bottom of the ingot and cause lamination in sheet. A decided segregation of Mn or MnO in the laminations would indicate that the formation of a "c region" might be the cause.

The foregoing indicates the importance of using the right Mn content to get good rimming steel and suggests that perhaps more might be done in controlling the rimming action by means of Mn. If Mn could be used to displace the customary ladle addition of Al in whole or in part, a nicer control might perhaps be accomplished. If a rapid ladle analysis for Mn could be made, the efficiency of the Mn addition as well as the Mn content might give an additional criterion of the dissolved O in the metal.

Nitrogen in Steel

Nitrogen differs from H in that N forms a solid compound with Fe, Fe_4N, which is fairly stable, so that no internal pressures in solid steel are set up by dissolved N. N is now recognized as one of the principal causes of aging phenomena in steel (16), which arise as a result of the precipitation of Fe_4N on standing at room temperature after quenching. Similar precipitation takes place during or after cold working. One effect of such precipitation is to increase the hardness and brittleness so that an aging steel shows a greater increase in hardness and brittleness for a certain degree of cold work than a non-aging steel. N, unlike H, can be "fixed" by Al, Ti, and other strong deoxidizers, and these are used to produce non-aging steels.

Bessemer steel usually contains considerably larger amounts of N than open-hearth steel. Fig. 13 shows the amount of N found in Bessemer steel as a function of the time of blow. A sharp rise in N only occurs in the latter portions of the blow. This is of particular interest in relation to Bessemer screw-stock, which is acknowledged to have superior machining properties; it is generally held that the best machinability is secured in "overblown" Bessemer steel. The reason probably lies mainly in the greater N absorption. The N increases the aging propensity of the steel, so that the chips become harder and more brittle under the cold-working action of the cutting tool and thus break off more easily.

Henning[17] has stated that Bessemer screw stock is rimmed without Al additions. This can probably be done the more readily, because the P present has a deoxidizing effect; the S present would also tend to diminish the CO evolution through the formation of an FeS-FeO conglomerate, which would not react as readily with C as pure FeO. For screw stock it would appear desirable to avoid the use of Al not only because any Al_2O_3 formed might dull the cutting tool, but because Al would tend to "fix" the N and thus destroy the desirable property conferred by N of greater hardening and embrittlement under the action of the cutting tool. Al would also tend to cause a finer grain, which would likewise decrease the degree of hardening after cold working and reduce the machinability. However, the small amounts of Al required to control the rimming action probably have a negligible effect on the aging characteristics of the inherent grain size.

The maximum amount of N absorbed by the steels as shown in Fig. 13 is a little over 0.020 per cent. This is about the maximum amount of N found in Bessemer steel. Chipman and Murphy[19] have recently determined the solubility of N in liquid Fe. At 1600 deg. C. this is about 0.40 per cent. Evidently, either the saturation value of N in liquid Fe is not attained during the Bessemer blow or else a considerable part of the N absorbed by the liquid steel is given off during solidification.

(To be continued)

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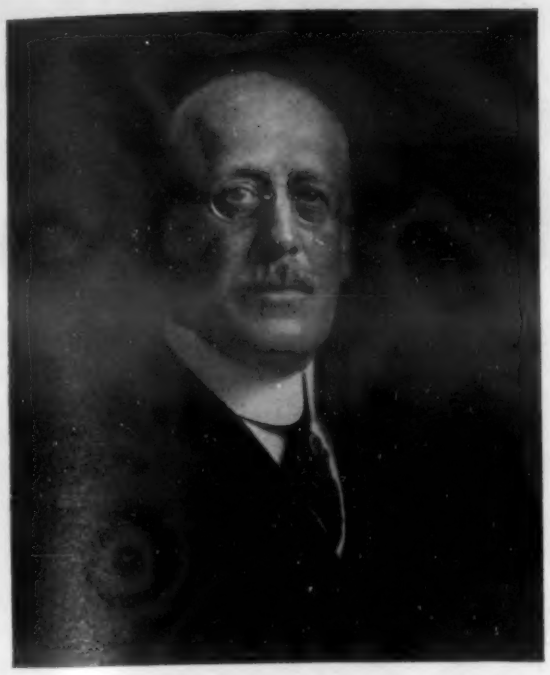
Letters to the Editor



"Father" of the Induction Furnace Art—E. A. Colby

To the Editor: E. A. Colby, who may justly be termed the "father" of the induction furnace art, to my mind is entitled to recognition as such.

He read my recent Case History on the subject of the submerged resistor furnace (METALS & ALLOYS, November, 1934) and then sent me a very nice letter, of which I enclose a copy and suggest the publication of it in METALS & ALLOYS.

G. H. CLAMER, President

Ajax Electrothermic Corp.,
46 Richmond St., Philadelphia.

Mr. Colby's Letter

March 11, 1935

Mr. G. H. Clamer, President,
The Ajax Metal Co.,
Philadelphia, Pa.
Dear Sir:

I have recently read with interest your article in the last November issue of METALS & ALLOYS on "The Development of the Submerged Resistor Induction Furnace" in which you credit me with being the progenitor of the Electric Induction Furnace.

As you are the only person within my knowledge who years ago visualized the practical utility of this type of furnace and had the courage to finance its development into its present commercial forms, it is most appropriate that you should be recognized as historian of this relatively new metallurgical art. It is for this reason that I desire to offer a few corrections in your previously published references to my early work—all of minor importance, except that they substitute facts for an author's conjectures and thereby enhance the value of the record.

The first four patents granted to me (three U. S. and one British) have the same issue date—May 20, 1890. The earliest filing date was April 14, 1887, U. S. No. 428,378, "Electric Furnace for Melting Metals." This patent contained seven combination claims covering the function and relation of the several parts of the furnace, prefaced by the customary statement that: "The precise form of the apparatus here shown and described is not essential in carrying out the invention; but it will be understood that the general plan is to cause the metal which is to be smelted itself to form the secondary circuit of an inductorium or converter, the primary circuit of which is supplied with suitable alternating, intermittent, or undulatory currents for inducing in such secondary circuit currents of a character which will melt the metal contained therein."

The claims with this preamble covered any positioning of the primary and secondary circuits relative to the iron core which the specific metal to be melted made expedient, even at the sacrifice of efficiency of operation.

The specification in this patent describes the advantages of this type of furnace for the melting and casting of various metals and especially *platinum in a vacuum* and the drawing shows the preferred form for such use.

Platinum being a precious metal, limited both in supply and demand—the average volume of metal in individual melts even today not exceeding fifteen (15) cu. in.—you will easily understand that the only operative position of the secondary circuit was next to the iron core. High temperature condition did not worry me as lime crucibles are poor conductors of heat and, since the melting and casting was in an evacuated container, the transfer of heat by convection currents was largely eliminated.

My name has, however, become associated with this particular arrangement of primary and secondary circuits as a representative type contrasted with Kjellin's deposition for melting base metals. I regret this only because it implies that I did not fully understand what I had invented and had not the vision to alter the arrangement of circuits when the imposed problem was changed.

When Kjellin's U. S. Patent was issued, I did not file an interference because my patents were controlling in this country and Great Britain, and Kjellin, recognizing this, we agreed that we best combine our interests as we did in forming the American Electric Furnace Co. as successor to the Induction Furnace Co., which I incorporated some years ago.

Shortly after Kjellin's visit to this country and the consolidation of our interests here and abroad he died, and our company, being largely financed by English capital, went on the rocks when the World War started.

Your inference that I was in the platinum business when I invented the induction furnace is in error as I had no connection with this industry until some eight years after my first design of apparatus for developing high temperature by induced electric currents. From 1881 to 1893 I was engaged in electrical research and engineering work—the first six years in the design and commercial manufacture of incandescent lamps in the Newark laboratory of Dr. Edward Weston. One of the problems I had in 1885 was the design of a very high candle-power incandescent lamp for use in the Government lighthouses. The then impossibility of conveying the large amperage currents through the glass seal of the bulb (even though the leading-in platinum wires were many and separated in the seal to distribute the strains) led me to design the so-called induction type of incandescent lamp in which the illuminant was a thin walled cylinder of carbon supported in an evacuated annular shaped glass bulb with a central tubular opening to slip over one leg of a transformer core on which latter was wound the primary inducing coil. In this case my secondary circuit, the carbon cylinder, was necessarily outside of the primary for otherwise I would have been hiding my light under a bushel.

At that time alternating current equipment was in the development stage so there was no incentive to seek patent protection. When a year or so later the Baker Platinum Co., from whom I obtained my supply of this metal, sought my advice in designing methods for improving their product with special reference to the elimination of occluded gases, I reversed the positions of the primary and secondary circuit of my original design to bring the length of the secondary circuit within the dimensions they imposed—filed my first patent application and assigned to them exclusive rights for use in melting precious metals. You have truly said, in your publication, that I failed to accomplish that which I set out to do but the failure was not due to the design of the furnace but rather to inability to obtain sufficient volume of metal for the secondary circuit to give commercial value to its use.

It was not until the fall of 1892 that I built my first laboratory models and quickly determined that, for melting precious metals, the core type of induction furnace had no future and began experiments with high frequency currents. I built my own high tension transformers for charging a battery of Leyden jar condensers and, with an air blast in the gap between the condenser terminals, secured an oscillating current of unknown frequency (no measuring instruments being available) but sufficient when traversing a few turns of copper wire, to melt an enclosed secondary consisting of one turn of coarse platinum wire (ends twisted together to form a closed circuit) about 5 in. in length.

These experiments witnessed by members of the Baker firm who supplied the platinum, demonstrated perhaps for the first time the use of induced high frequency currents for the melting of metals.

If you recall the state of development of alternating current equipment, including condensers and measuring instruments, when you and Dr. Northrup took up the design of the coreless type of furnace, you will appreciate why the toy I had 42 years ago was not coveted by the capitalist of that day and why I perforce, abandoned further work in this direction and took up other problems in the metallurgy of platinum which have largely absorbed my attention since.

The erratic behavior of my spark gap, however, gave me much serious thought, and I early sought help from specialists in designing high frequency generators. Among these one was Lt. F. Jarvis Patten, U. S. N., author of several articles on this subject in the *Electrical World* (1893). I recently unearthed some correspondence with Patten wherein he quoted me prices on experimental equipment which he predicted would help me out of my difficulties. At Dr. Northrup's suggestion I am forwarding these to you as of possible historical interest—they need not be returned as I am cleaning out much of the accumulated debris of unprofitable labor.

Patten died before completing the design of a high frequency generator for my use and so I shall never know where the weak link in his theory lay, but I suspect that, as he built up his frequency, his effective voltage dropped.

It was not until the life of my basic furnace patents had nearly expired that, failing to interest capital in their commercial use, I personally financed the Induction Furnace Co. and contracted with the General Electric Co. to build the first commercial sizes in 1904. Later other models were built by the Crocker-Wheeler Co., Ampere, N. J. The first cash sale, without prior demonstration, was made to the Diston Saw Co., and the first crucible steel was made at their Tacony plant in April, 1905. Many tons of steel were made in this furnace rated at 60 kw. Another furnace of the same capacity was used at Exton, Pa., for making experimental silicon alloys, especially ferrosilicon from 18 to 50 per cent Si content.

So much attention has been given in recent years to the study of the effect of occluded gases in metal, I am surprised that the evacuated type of induction furnace described in my early patents has had no application in this country. I presume you know of the extensive work in this line by Heraeus and Rohn in Germany and the absorption of this business by Siemens & Halske. Could not the Wyatt furnace be easily adapted for such use with alloys whose constituent metals did not differ too greatly in volatilizing temperatures and perhaps add valuable qualities to the product?

I am enclosing a photograph of my little laboratory in Newark taken in May, 1893, which shows the crude equipment I had when I began to experiment with high frequency currents. I have marked some of the parts for identification on a duplicate blue-print.

You have been so generous in your references to my early work, I hope you will accept the above statement of facts

The laboratory in which Mr. Colby began experimenting with High Frequency Current (1893).

as offered merely to correct inferences drawn from imperfect data and not in any sense to detract from the credit due those who independently or, following the clue of predecessors, have by persistent effort, technical skill and the financial support of industrialists like yourself—converted an idea into a commercial form of great utility.

To Dr. Northrup, Wyatt and yourself belong both honor and profit.

Very truly yours,

54 Austin St.,
Newark, N. J.

EDWARD A. COLBY,
Consulting Engineer.

[As we are about to go to press, announcement is made of the sudden death of Mr. Colby in Newark, N. J., on June 1, from a heart attack.—The Editor.]

Protection of Radium Workers

To the Editor: After studying the original article by Kaye, Bell and Binks and Mr. Isenburger's condensation of the same*, we find that there are several additional points that should be mentioned and taken into consideration when these data are applied to radium used for radiographic rather than medical purposes.

The data, as presented by Kaye, Bell and Binks, are calculated to apply to persons handling radium in medical centers for 7 to 8 hours daily. The table included is therefore based on a "tolerance dose" of 0.2 röntgens in a normal working day of 7 or 8 hours, or 10^{-5} röntgens per second over a period of time. Thus the lead thicknesses given in the table afford adequate protection to workers who may be at the specified distance from the radium throughout a 7 or 8 hour-day.

There are few instances in which such constant proximitity is required in radiography. In most cases in which radium is used for industral radiography, a portion of the room can be screened off to protect passers-by and there is no need for the operator to remain near the radium, or even in the same building when the exposure is made. The films and the appliance for holding the radium capsule can be placed in position prior to removing the radium from the portable container. The operation of transferring the radium from the container to its position for use should require only a few seconds, certainly less than ½ min., and during this time there is no need for the operator to be less than 1 ft. from the radium capsule. The same applies when the radium is being removed and replaced in the container.

As Mr. Isenburger has pointed out, the exposures in radium radiography are long and the number of changes to be made during one day are therefore small in number. Thus the actual exposure suffered by the operator is limited to a few minutes per day unless he is unduly careless.

The table published by Mr. Isenburger is also misleading in that he states "in our field we are dealing with much larger quantities of radium . . . than the routine medical attendant" and fails to state that there is no record of as large quantities as 2, 5 or 10 grams of radium ever having been used in industrial radiography. In fact, it is only in rare instances that as large a source as 500 milligrams (0.50 grams) is used and the amounts of radium usually used vary from 100 to 300 milligrams (0.1-0.3 grams).

By examining the chart in Mr. Isenburger's article it can be seen that even with 0.5 of a gram of radium the maxi-

(*Continued on page 168*)

* "The Protection of Radium Workers," by H. R. Isenburger, METALS & ALLOYS, April, 1935, page 100

The Annual Meeting of the American Society for Testing Materials

IT is expected that the Thirty-Eighth Annual Meeting in Detroit, June 24 to 28, of the American Society for Testing Materials, will be in many respects an outstanding one. Fifteen technical and other sessions have been scheduled.

In addition to the technical activities of the week, including meetings of the society's many committees and sub-committees, an exhibition of testing and allied apparatus has been arranged. This will be the Third Exhibit of the society. The sessions and the exhibition will be held at the Book-Cadillac Hotel with all activities, including the exhibition, located on the fourth or grand ballroom floor of the hotel.

The Technical Program

THE usual comprehensive program of technical papers and reports of leading committees has been arranged. The sessions and programs relating to metals and alloys, directly or indirectly, is as follows:

Tuesday, June 25

MORNING

"Relations of Specifications to the Engineering Profession," by C. F. Hirshfeld, chief of research department, Detroit Edison Co.
Presidential address by Hermann von Schrenk.
Annual report of executive committee by C. L. Warwick, secretary-treasurer.

AFTERNOON

Testing; Reports of Administrative Committees

Report of committee E-10 on standards.
Report of committee E-9 on research.
Report of committee E-1 on methods of testing.
"Relation Between the Tension Static and Dynamic Tests," by H. C. Mann, Watertown Arsenal.
"Hardness Testing of Light Metals and Alloys," by R. L. Templin, Aluminum Co. of America.
"A New Method and Machine for Dynamic Hardness Testing," by W. M. Patterson, Tinius Olsen Testing Machine Co.
Discussion on significance of "yield strength" of metals in design and specifications.

EVENING

Symposium on the "Place of Materials in Automobile Roads and Rides."

Wednesday, June 26

MORNING

Steel, Wrought Iron, Cast Iron

Report of committee A-2 on wrought iron.
Report of committee A-6 on magnetic properties.
Report of committee A-9 on ferroalloys.
Report of committee A-1 on steel.
"Effect on the Elastic Properties of Heavy (3½-in.) Steel Plate by Cold Bending and by Subsequent Stress Relief," by C. H. Gibbons, Baldwin-Southwark Corp.
"Endurance Testing of Rear Axle Gears and Gear Steels," by J. O. Almen and A. L. Boegehold, General Motors Corp.
Report of committee A-3 on cast iron.

AFTERNOON

Marburg Lecture

"Aircraft: Materials and Testing," by Dr. L. B. Tuckerman, principal scientist and assistant chief, division of mechanics and sound, National Bureau of Standards, Washington.

EVENING

Annual Dinner

Award of Dudley medal to C. A. Hogentogler and E. A. Willis.
"Relationship of Materials to the House of Today and Tomorrow."
"The Federal Housing Problem," by Stewart McDonald, assistant administrator, Federal Housing Administration.
"Role of Materials in Modern Housing," by J. E. Burchard, vice president, Bemis Industries Inc.

Thursday, June 27

MORNING

Corrosion

Report of committee A-10 on iron-chromium, iron-chromium-nickel and related alloys.
Report of committee A-5 on corrosion of iron and steel.
Report of sectional committee on specifications for zinc coating of iron and steel.
"Continuous Flow Corrosion Tests of Steel Pipe," by H. S. Rawdon and L. J. Waldron, National Bureau of Standards.
Report of committee B-3 on corrosion of nonferrous metals and alloys.
Report of committee D-14 on screen wire cloth.
"Corrosion Testing Methods," by H. E. Searle and F. L. La Que, International Nickel Co.
"Control of Corrosion in Air Conditioning Equipment by Chemical Methods," by C. M. Sterne, Metropolitan Refining Co., Inc.
Report of committee D-19 on water for industrial uses.

Coal

Report of sectional committee on classification of coals.
Report of committee D-5 on coal and coke.

EVENING

Effect of Temperature on Metals, Fatigue of Metals

Report of joint research committee of A. S. M. E. and A. S. T. M. on effect of temperature on the properties of metals.
"Some Tests on Tin Bronzes at Elevated Temperatures," by J. W. Bolton Lunkenheimer Co.
"Influence of Time on Creep of Steels," by A. E. White and C. L. Clark, University of Michigan and R. L. Wilson, Timken Steel & Tube Co.
"Creep Characteristics of Aluminum Alloys," by R. R. Kennedy, Army Air Corps, Wright Field.
Report of research committee on fatigue of metals.
"The Rotating-Arc Fatigue Machine for Testing Small Diameter Wire," by J. N. Kenyon, Columbia University.
"High-Speed Fatigue Tests of Several Ferrous and Nonferrous Metals at Low Temperatures," by W. D. Boone and H. B. Wishart, University of Illinois.

Friday, June 28

MORNING

Symposium on Spectrographic Analysis

"Spectrographic Analysis of Steel Samples," by W. R. Brode, Ohio State university.
"Use of the Spectrograph in the Platinum Industry," by H. E. Strauss, Baker & Co. Inc.
"Quantitative Spectrographic Analysis of Magnesium Alloys for Manganese and Silicon," by J. S. Owens, Dow Chemical Co.
"Spectrographic Determinations of Impurities in Commercial Cadmium," by F. W. Lamb, Bohn Aluminum & Brass Corp.
"Purification of Graphite Electrodes for Spectrographic Use," by G. W. Standen and L. Kovach Jr., New Jersey Zinc Co.

Refractories

Report of committee C-8 on refractories.

AFTERNOON

Nonferrous Metals, Metallography

Report of committee B-1 on copper wire.
Report of committee B-4 on electrical heating, electrical resistance and electric furnace alloys.
Report of committee B-5 on copper and copper alloys, cast and wrought.
Report of committee E-4 on metallography.
Report of committee B-7 on light metals and alloys, cast and wrought.
Report of committee B-6 on die cast metals and alloys.
Report of committee B-2 on nonferrous metals and alloys.
"A Survey of Testing in the Precious Alloy Field with Special Reference to Testing Requirements for Duplex Alloys," by T. A. Wright, Lucius Pitkin, Inc.
"Making and Testing Single Crystals of Lead," by B. B. Betty, University of Illinois.

The Exhibitors and Their Exhibits

NEARLY 25 exhibitors have taken space for the exhibition, including leading companies in the testing instrument and related apparatus fields. Briefly the list of exhibitors and what they will display is as follows:

Baldwin-Southwark Corp., Philadelphia.—Hydraulic testing machine for high-temperature work, torsion impact machine, Southwark-Templin stress-strain recorder, DeForest scratch recorder and strain measuring instruments. Also one 75,000-lb. cement and concrete tester (Southwark-Emery type). *Booth No. 1.*

Bausch & Lomb Optical Co., Rochester, N. Y.—GBILS metallographic equipment with polarized light attachments and grain size eyepiece, FSM microscope and camera, small Littrow quartz spectrograph, arc stand and condensing lens, spectrum viewing box and density comparator, plating microscope, AKW and BKT microscopes, Abbe refractometer and dipping refractometer, Duboscq colorimeter. *Booth No. 2.*

Christian Becker, Inc., New York City.—Various types of balances, including: Analytical "Chainomatic" with magnetic damper, micro, surface tension, laboratory, etc. *Booth No. 15.*

Central Scientific Co., Chicago.—New developments in scientific laboratory equipment for research and routine analysis. *Booth No. 27.*

Detroit Testing Machine Co., Detroit.—A 30,000-lb. Universal testing machine, suitable for general tensile, transverse and compression testing within its capacity; a low priced practical tester for laboratory or foundry use; a 4,000-lb. capacity portable tensile tester; a direct reading power Brinell especially adapted to rapid, production Brinelling without grinding parts or use of microscope; a direct reading Brinell attachment which adapts any standard power Brinell machine to direct reading same as above; a power-driven ductility or sheet metal tester, capacity 20,000 lb., $\frac{1}{8}$ in. thickness; a portable sheet metal tester; a torsion tester, bench type, suitable for light torsion testing, and torsion testers (portable) especially adapted to the testing of bolts, screws, lockwashers, handles, etc., and for setting frictions on air or electric wrenches. This tester is used in the same manner as a hand die or tap wrench. Capacity 1,000 inch-pounds. None of the above machines have been previously exhibited. *Booth No. 14.*

Eberbach & Son Co., Inc., Ann Arbor, Mich.—Testing and laboratory instruments, including viscosimeters, metallographic polishing equipment, electrolytic analysis of metals machine, etc. *Booth No. 3.*

Emil Greiner Co., New York City.—Petroleum testing apparatus, constant temperature viscosity baths, viscosity tubes (brass and stainless steel), thermo-regulators and relays, gages for testing A.S.T.M. equipment for conformity with dimensional requirements; exhibit of general interest showing steps in thermometer manufacture from glass works to complete instrument. *Booth No. 17.*

Federal Pneumatic Systems, Inc., Chicago.—Federal laboratory air classifying unit for fineness classification of pulverized material, dust, etc. *Booth No. 37.*

General Motors Research Laboratories, Detroit.—Stroboscope crankshaft for use in studying oil flow in rapidly moving automobile parts; photoelastic stress study for determining distribution of stresses by means of celluloid models of automobile parts such as gears, frame joints, etc.; rear axle dynamometer used in endurance testing of rear axle gears and gear steels.

J. B. Hayes, Inc., Urbana, Ill.—Display of diffraction X-ray laboratory unit, and microphotometer, and various types of fatigue testing machines.

Illinois Testing Laboratories, Inc., Chicago.—Portable and stationary indicating pyrometers for all applications in ranges of 0 to 300 to 0 to 3,000 deg. F.; indicating resistance type distant reading thermometers, portable and stationary, in ranges from minus 20 to plus 350 deg. F.; Boyle velometer, an instantaneous direct reading air velocity measuring instrument; pyrometer thermocouples and accessories. *Booth No. 33.*

The Instruments Publishing Co., Pittsburgh.—INSTRUMENTS, the magazine of measurement and control; INSPECTION & TESTING; books on measurement and control. *Booth No. 40.*

Leeds & Northrup Co., Philadelphia.—The L&N capacitance-conductance bridge, a shielded assembly for rapid, precise measurement of power factor up to 50 kc., operating. The assembly is also used for calibrating other instruments and for studying specific inductance capacity. Also in operation, an Owen bridge 1,000-cycle assembly, designed especially for the testing of magnetic properties of iron and steel as covered by Specification A 34-33 of the A.S.T.M. Embodying the recommendations of the society's Committee on Magnetic Testing, it is valuable for measuring the permeability and core loss of sheet irons and steels at low inductions. A new 3-dial shielded mica capacitor used as a standard of reference in bridge circuits—commercial, audio and higher frequencies—and a 6-dial shielded resistance box offering relatively high accuracy at moderate cost. Glass electrode equipment for measuring pH will also be on display. *Booth No. 29.*

"Metals & Alloys," New York City.—METALS & ALLOYS, the magazine of metallurgical engineering; technical books. *Booth No. 40.*

Tinius Olsen Testing Machine Co., Philadelphia.—New types of testing machine equipment and instruments, together with the latest type "Vibrometer" and equipment for demonstrating the value of dynamically balancing rotating parts and equipment for its correction. *Booth No. 10.*

The Palmer Co., Cincinnati (St. Bernard).—Laboratory thermometers, A.S.T.M. thermometers, demonstration of how thermometers are made by a skilled thermometer maker. *Booth No. 36.*

Precision Scientific Co., Chicago.—Laboratory metalware and testing instruments for petroleum, cement, bituminous materials; a 4-compartment refrigerated cloud and pour test bath; Indiana oxidation bath for determining the characteristics of motor oils and gum test bath for testing gasolines. *Booth No. 19.*

Riehle Testing Machine Division of American Machine and Metals, Inc., New York City.—Universal testing machine; combination Charpy, Izod and tension impact machine, etc. *Booth No. 8.*

E. H. Sargent & Co., Chicago.—Testing and laboratory instruments, glassware and metalware and other equipment used in testing and research work. *Booth No. 20.*

The Shore Instrument & Mfg. Co., Jamaica, N. Y.—General hardness testing equipment, monotron for metals and all non-metallic materials, scleroscope 100 per cent portable for metals and solid materials, durometer for rubber and like materials, elastometer for measuring elasticity of rubber, etc.

Steel City Testing Laboratory, Detroit.

C. J. Tagliabue Mfg. Co., Brooklyn.—A complete line of oil testing instruments, "TAG" oil testing thermometers and A.P.I. hydrometers made in accordance with A.S.T.M. specifications. Steps in the manufacturing processes necessary to produce both thermometers and hydrometers will be shown by means of actual specimens. Featured instruments will include the new TAG line of certified hydrometers; the TAG saybolt thermostatic viscosimeter with electric timer; the new "TAG-Macbeth" daylight lamp; the new TAG A.S.T.M. four-unit cloud and pour test apparatus as well as the latest, up-to-date instruments for determining color, flash and fire, carbon residue, distillation range, burning quality, etc. *Booth No. 6.*

Displays by society committees and research laboratories, of special apparatus and equipment which they have developed, will form an interesting section. The A. S. T. M. exhibit will include non-commercial apparatus sponsored by the society's committees or research laboratories for the carrying out of special tests and research work.

The annual dinner is scheduled for Wednesday evening, June 26, at which the Charles B. Dudley Medal will be awarded to C. A. Hagenfogler and E. A. Willis.

(*Continued from page 166*)

mum "tolerance distance" required to protect a person from continuous exposure is only 20 ft. with 0.2 grams the "tolerance distance" is only 10 ft. for continuous exposure. These distances are even less for occasional exposures. The space required to handle radiographic examinations safely is, therefore, quite small.

The British workers also made a rather complete study of portable containers for transporting radium. They found that the small wooden containers lined with 1 cm. (0.39 in.) of lead used for transporting radium by hand are suitable for occasional handling of small quantities (100 milligrams or less) of radium. If larger quantities of radium are to be transported larger boxes fitted with centrally located lead-lined containers should be used. These workers also noted that distance gave more protection than lead and that a light bulky package employing no lead might be more effective than a smaller lead-lined container. They also designed several portable containers weighing less than 11 lb., the largest being a cube with 12-in. sides which gave adequate protection in transportation. Since transportation of radium does not necessitate continuous handling, it is difficult to see the need for radium cases so large that two men would be required to handle them.

R. A. GEZELIUS
C. W. BRIGGS

Division of Physical Metallurgy,
Naval Research Laboratory,
Washington.

Importance of Hardness in Precious Metal Manufacture

To the Editor: In the manufacture of alloys to be used for castings and plates in the dental industry, certain precautions must be taken to reduce them from the cast specimen to the finished product. The anneal is important but, in the reducing procedure, stress must be focused on the hardness. For instance, if alloys are cold worked, hardness readings must be taken after each pass of a rolling operation.

If a casting of a certain hardness after an anneal, say B90 on the Rockwell machine, record must be kept of the following hardness numbers. The hardness may increase one point per pass until it reaches say B99. At this point another pass finds the casting at the same figure and any further passes will not increase the specimen hardness. If the casting is rolled after the final hardness has developed, considerable trouble will set in. In annealing regardless of the quench, oil, water, or air, the specimen will usually crack up.

ERIC H. SWANSON

Prince Bay, Staten Island, N. Y.

CURRENT

Metallurgical Abstracts

A Digest of the Important Metallurgical Developments of the World

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Read the Current Metallurgical Abstracts each month to keep posted on the world's Metallurgical Developments.

CLASSIFICATIONS

ORE CONCENTRATION (1)
- Crushing, Grinding & Plant Handling (1a)
- Gravity Concentration (1b)
- Flotation (1c)
- Magnetic Separation (1d)
- Amalgamation, Cyanidation & Leaching (1e)

ORE REDUCTION (2)
- Non-Ferrous (2a)
- Ferrous (2b)

MELTING, REFINING AND CASTING (3)
- Non-Ferrous (3a)
- Ferrous (3b)

WORKING (4)
- Rolling (4a)
- Forging & Extruding (4b)
- Cold Working, including Shearing, Punching, Drawing & Stamping (4c)
- Machining (4d)

HEAT TREATMENT (5)
- Annealing (5a)
- Hardening, Quenching & Drawing (5b)
- Aging (5c)
- Malleableizing (5d)
- Carburizing (5e)
- Nitriding (5f)

FURNACES, REFRACTORIES AND FUELS (6)

JOINING (7)
- Soldering & Brazing (7a)
- Welding & Cutting (7b)
- Riveting (7c)

FINISHING (8)
- Pickling (8a)
- Cleaning, including Sand Blasting (8b)
- Polishing & Grinding (8c)
- Electroplating (8d)
- Metallic Coatings other than Electroplating (8e)
- Non-Metallic Coatings (8f)

TESTING (9)
- Inspection & Defects, including X-Ray Inspection (9a)
- Physical & Mechanical Testing (9b)
- Fatigue Testing (9c)
- Magnetic Testing (9d)
- Spectrography (9e)

METALLOGRAPHY (10)

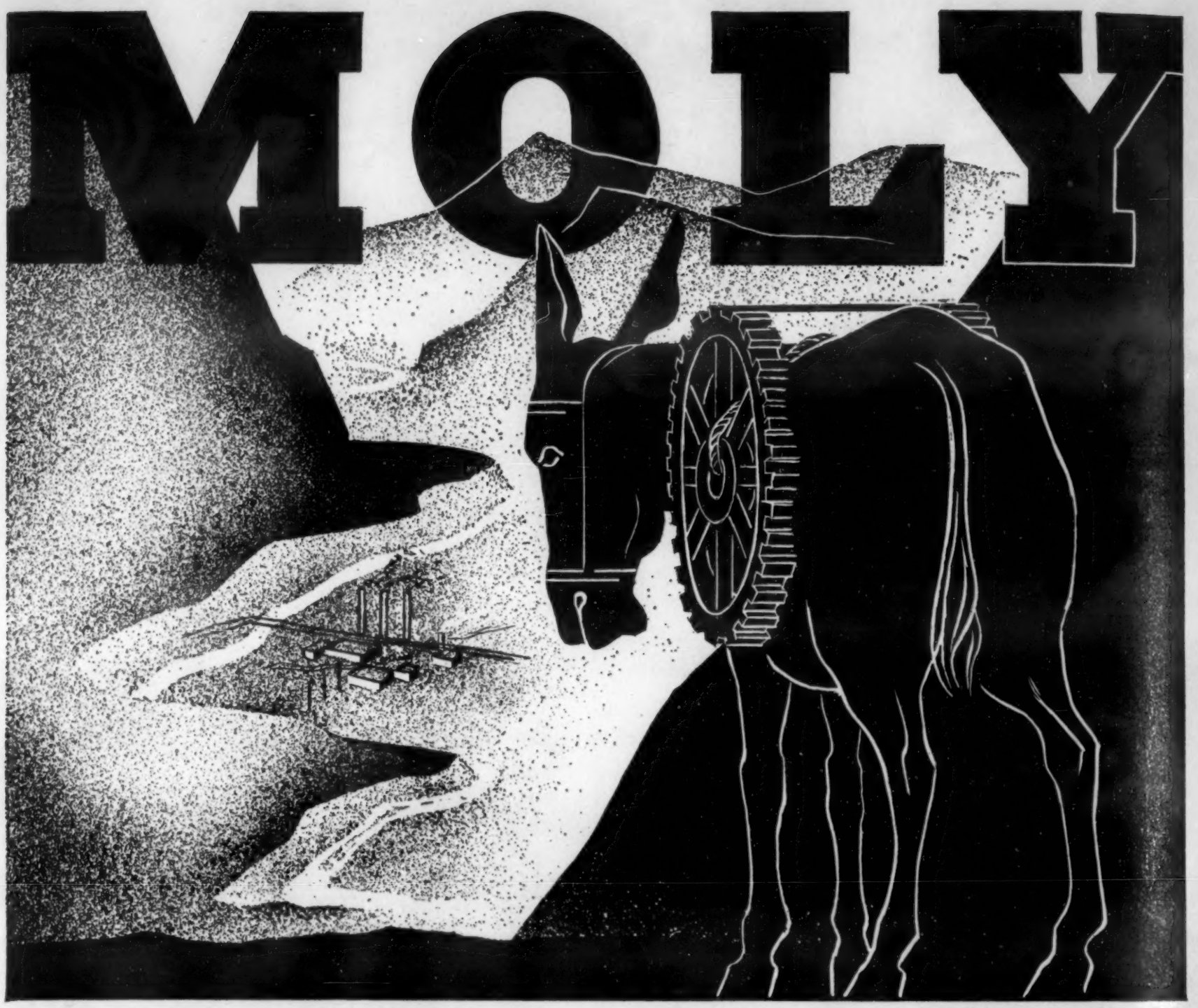
PROPERTIES OF METALS AND ALLOYS (11)
- Non-Ferrous (11a)
- Ferrous (11b)

EFFECT OF TEMPERATURE ON METALS AND ALLOYS (12)

CORROSION AND WEAR (13)

APPLICATION OF METALS AND ALLOYS (14)
- Non-Ferrous (14a)
- Ferrous (14b)

GENERAL (15)
- Economic (15a)
- Historical (15b)



where replacements are costly

A STAMP MILL in a trackless Andean interior. . . . Picture the time and money losses involved in parts replacements under such circumstances! And yet there are literally thousands of nearby instances — in industrial, engineering, oil, mining and other projects — where replacement problems are no less serious . . . where inaccessibility, removal and installation difficulties, labor, transportation, shutdowns and what-not exact heavy tolls . . . where mechanisms ought to be qualified to let their users "put them to work and forget them."

Hence, where replacements are costly there should be no compromise with quality. . . . The unquestionable "best" in irons and steels is ultimately the least expensive. Toward attaining it the various alloying elements and combinations become a subject for intensive consideration. *There are hundreds of cases in which Molybdenum's addition to, or substitution for, other alloys has bettered products.* Results have proved that the increase in life is attained at the lowest possible cost.

Would you be interested in some substantiating facts and findings? WRITE for these books: "*Molybdenum in* 1934" and "*Molybdenum in Cast Iron* — 1934 *Supplement.*" Also keep informed on current "Moly" developments by asking to be put on the mailing list of our periodical news-sheet, "*The Moly Matrix.*" Feel free, too, to consult our metallurgists and to use our Detroit experimental laboratories on any alloy problems. Climax Molybdenum Company, 500 Fifth Avenue, New York. (In Canada: Railway & Power Engineering Corp., Ltd.)

CLIMAX **Mo-lyb-den-um**

1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

1e. Amalgamation, Cyanidation & Leaching

Gold Ore from Wine Harbour Gold District, Guysborough County, Nova Scotia. *Canadian Department of Mines, Mines Branch Report*, No. 743, 1934, pages 34-36. Amalgamation recovers 85-88% of the Au. Cyanidation extracts 96%. The ore is not amenable to flotation. A flow sheet is suggested. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

2a. Non-Ferrous

New Ceramic Materials for the Investigation of the Electrolysis of Commercially Important Melts (Neuere keramische Materialien als Hilfsmittel zur Erforschung technologisch wichtiger Schmelzelektrolysen). HEINZ BORCHERS. *Metallwirtschaft*, Vol. 14, Feb. 22, 1935, pages 149-151. Crucibles and tubes made of sintered corundum and Degussa clay withstand the temperatures and chemical action encountered in the electrolysis of Al, Mg and similar salts. To obtain good results it is necessary to fire the articles at a high temperature; it is recommended that the refractory after receipt from the manufacturer be heated to 1975° C. in an oxidizing or neutral atmosphere. Properly prepared crucibles withstand the action of cryolite, NaF and mixtures of these with clay at 1345° for 1 hour. A small amount of the crucible dissolves in the melt, but being Al it does no harm. The salts used in Mg electrolysis do not attack these materials, but for the electrolysis of Be salts it is better to use crucibles made of fired Be oxide. The quality of the crucibles and the results obtained with them vary somewhat. CEM (2a)

Smelting Complex Type Ashes. C. C. DOWNIE. *Journal Society of Chemical Industry*, Vol. 53, Nov. 23, 1934, pages 996-998. Description of the smelting of waste material from printing establishments containing Sb, Pb and Sn when As and Cu are present. VVK (2a)

The Reduction by Hydrogen of Stannic Oxide Contained in H.-C. Copper. W. E. ALKINS & A. P. C. HALLOWES. *Journal Institute of Metals*, Vol. 56, 1935, Advance Copy No. 689, 5 pages. Samples of 16-gage wire containing 0.021% SnO_2 were heated for different periods in a stream of H_2 at 550° to 850° C. Analyses of the heated wires proved that SnO_2 would be reduced at the temperatures and times used for determining O by H reduction. JLG (2a)

The N'Kana Smelter. A. D. WILKINSON & F. C. BOSQUI. *Mining & Metallurgy*, Vol. 15, Sept. 1934, pages 366-373; Oct. 1934, pages 412-414. From a paper first published in Mining magazine, Nov. 1933, pages 265-278. Describes the new Cu reduction plant of the Rhokana Corporation at N'Kana, Northern Rhodesia. The prominent parts of the equipment are the concentrator and smelter. Other parts described are the reverberatory furnace, converting, casting and accessory equipment. VSP (2a)

Zinc Production by Dry Process (Zinkgewinnung auf trockenem Wege). V. TAFEL. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Jan. 26, 1935, pages 110-113. Processes of Zn production by roasting, reducing of roasted ore to metal, and refining methods are discussed and equipment described. Ha (2a)

2b. Ferrous

The Blast Furnace as a Chemical Plant. C. O. BANNISTER. *Journal Society of Chemical Industry*, Vol. 53, Nov. 23, 1934, pages 991-996. A review of the blast furnace from the standpoint of the chemical engineer, particularly the recovery of waste products and the use of the blast furnace as a chemical plant. VVK (2b)

Making Sponge Iron in Norway According to Edwin Method (La fabrication du fer spongieux par le procédé Edwin en Norvège). IVAR J. MOLTKE-HANSEN. *Journal du Four Electrique*, Vol. 44, Feb. 1935, pages 57-58. The Edwin method, developed at Bochum, treats iron ore at 1000° C. with a mixture of CO and H_2. Gases leaving the furnace containing 17-18% CO_2 and about 10% H_2O, are cooled to condense H_2O and passed through arc furnaces similar to Birkenland-Eyde where the CO_2, heated to 1800°-1900° C. is converted into CO by passing through a layer of C. The gases are cooled to 1100° C. and reintroduced into the furnace. The Bochum installation functioned smoothly producing about 40 tons of sponge Fe per day. In order to reduce costs, a similar installation is being planned for Norway. JDG (2b)

Reduction of Iron Ore in Rotary and Electric Furnaces (La réduction du mineral de fer au four tournant et le four électrique). *Journal du Four Electrique*, Vol. 44, Feb. 1935, page 54. Brief sketches of Basset, Edwin, Wiberg and Krupp methods for direct Fe production. JDG (2b)

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3. MELTING, REFINING AND CASTING

Oven Drying of Cores and Molds. E. G. FIEGEHEN. *Foundry Trade Journal*, Vol. 51, July 12, 1934, pages 21-23. See *Metals & Alloys*,, Vol. 5, Dec. 1934, page MA 557. CEJ (3)

The Testing of Steel Foundry Sands and the Control of Supplies by Specification. T. R. WALKER. *Foundry Trade Journal*, Vol. 51, Nov. 15, 1934, pages 305-307; Nov. 22, 1934, pages 323-325, 328. A paper read before the Sheffield Branch of the Institute of British Foundrymen. It is shown that the important qualities of a foundry sand, namely, refractoriness, mechanical strength in green and dry states, permeability to gases, plasticity, grain size and consistency of supply, are in the main susceptible to numerical evaluation. Methods of test are briefly described and their application to the specification of foundry sands is outlined. Specifications are given for facing and raw molding sands and fine, medium and coarse silica sand for use in a steel foundry. The establishment of routine sand testing by agreed methods and the control of foundry sands by specification would put the purchase and use of sands on a more satisfactory basis than the trial and error system which has been so common hitherto. CEJ (3)

Mold for Large Cylinder Casting (Étude du Moulage en Terre au Trousseau d'un Cylindre Basse Pression pour Machine Marine de 900 CV). L. PONCIN. *Bulletin de l'Association Technique de Fonderie*, Vol. 9, Jan. 1935, pages 1-13. Paper presented before the A.T.F., Apr. 1933. Molding details and sketches for preparation of a mold for a marine engine cylinder weighing 7700 lbs. The mold was largely composed of brick. WHS (3)

Factors Influencing the Density and Soundness of Castings. E. LONGDEN. *Metal Industry*, London, Vol. 45, Aug. 10, 1934, pages 129-130. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 89. HBG (3)

A Comparison of Some Wet Methods Used for the Fineness Test of Sands and Clays. R. C. HILLS. *Transactions American Foundrymen's Association*, Vol. 5, Dec. 1934, pages 101-128. Results are reported of a comparative study of 5 wet methods for determining the fine sized particles of clays, molding sands, soils, and other fine grained natural or artificial substances. Special attention is given to molding sands. Within certain limits the different types of apparatus described, with the exception of the elutriation method give comparable results. The effect of different electrolytes and the temperature and character of the water used are also presented. CEJ (3)

Use of the Pipette Method in the Fineness Test of Molding Sand. CLARENCE E. JACKSON & C. M. SAEGER, JR. *Bureau of Standards Journal of Research*, Vol. 14, Jan. 1935, pages 59-65. The fineness, or the size distribution, of the constituent particles of a material is an important factor in determining many of the physical characteristics. No great difficulty is encountered in sizing the larger particles by the use of sieves, but for particles finer than 50 microns in diameter other methods must be employed. The pipette method has been satisfactorily used in analysis of particle sizes of soils. Details of the development and use of the pipette method in the fineness test of molding sands are outlined. The method of computation and scope of results are shown by typical examples. A rapid method suitable for foundry control work and routine testing is suggested. The equipment necessary in the pipette method is easily assembled, simple to operate, the time of operation is short, information obtained is wider in scope, and the reproducibility of results is greater than is obtained by other methods now in use. WAT (3)

Molding of a Steam Cylinder for a Gas Compressor in a Clay Mold (Formen eines Dampfzylinders für einen Gaskompressor nach Lehmmodell). G. SCHÜLE. *Giesserei*, Vol. 22, Feb. 1, 1935, pages 55-57. Full description of procedure. Ha (3)

Difficult Tests for Founding Properties. J. T. MACKENZIE. *Metal Progress*, Vol. 27, Mar. 1935, page 56. While a test is available for routine determinations of "castability" no such specimen is available for study of shrinkage and other founding properties. WLC (3)

3a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

The Electrolytic Refining of Mercury. E. NEWBERY & S. M. NAUDE. *Transactions Electrochemical Socieity*, Vol. 64, 1933, pages 189-200. See *Metals & Alloys* Vol. 5, May 1934, page MA 174. (3a)

Indicating Pyrometers Are Profitable in the Metal Industry. N. D. PUGH. *Metal Industry*, N. Y., Vol. 33, Apr. 1935, pages 117-119. General use of pyrometers in non-ferrous melting plants handling Sn, babbitt, solder, white metal, Al, brass, bronze and Cu is discussed. PRK (3a)

Modified Betts Process Yields Refined Lead Bullion. T. E. HARPER, JR. & GUSTAVE REINBERG. *Engineering & Mining Journal*, Vol. 136, Mar. 1935, pages 119-120. The Cerro de Pasco Copper Corp., at La Oroya, Peru, has built an electrolytic plant with basic changes in the Betts process consisting in limiting the corrosion period of the anode and in recovering by counter-current dip-washing the concentrated fluosilicate solution residual in the pores of the slime blanket. WHB (3a)

Vertical Casting of Copper at Carteret B. H. STROM. *Engineering & Mining Journal*, Vol. 136, Feb. 1935, pages 59-62. To overcome the disadvantage of horizontally cast cakes the so-called wedge cake is used. It is cast edgewise to reduce the area of the set surface. The procedure insures 2 smooth sides for rolling. In order to discharge these cakes from the mold they are made with a decided taper, sufficient to make the cake drop freely when the mold is inverted. To roll the wedge shaped cake, preliminary passes in the transverse direction are required to flatten it to a condition where effectual reductions may be achieved. Even then irregular shaped slabs or extra long "ears" on the finished material may result, necessitating excessive trimming and more scrap. Molds have been developed with center cores corresponding approximately to the size and shape of the cavity desired, leaving a minimum of metal to be removed by machine. An arrangement of double mold and several single molds in position on the casting wheel is shown. The hinged bottom door of the double mold has been swung open in the discharging position, and the others are closed. The door consists of cast Cu and is fastened securely in a steel frame. It is held tightly against the mold bottom by a bale. The molds are poured on the wheel in pairs and 2 molds are filled simultaneously from a casting ladle equipped with 2 spouts. With the mold kept at a reasonably constant temperature, the mold cavity is maintained at a constant cross-section and the Cu castings cool quickly and shrink rapidly, so that upon reaching the position over the bosh the parallel-sided shapes drop from the molds without any hold-up. After release of the cake the mold is inspected and given the regular bone-ash solution wash, after which the bottom door is swung back in position and the bale adjusted to a tight fit by hand. The maintenance of a correct temperature of cooling water is essential. The temperature of the Cu during tapping must be carefully controlled at about 2040° F. Production of vertical cakes in 1934 totaled 46,600,000 lb., and in addition 8,700,000 lb. of vertically cast wirebars, and 9,700,000 lb. of billets. WHB (3a)

Study of Dense Bronze Castings (Studio sui getti di bronzo a tenuta). G. SOMIGLI. *Industria Meccanica*, Vol. 7, Feb. 1935, pages 115-125. The various factors which influence the density of bronze castings were experimentally studied. Molding methods, shape of mold, composition of alloy, starting material, melting procedure and temperature of pouring were investigated and the micrographic structures compared. The best melting temperature is 1090°-1100° C. The numerous tests are described in detail. 21 references. Ha (3a)

Sound Die-Castings of Aluminum Bronze Produced by the Use of Vacuum. CHAS. O. HERB. *Machinery*, N. Y., Vol. 41, Mar. 1935, pages 404-405. Describes a die-casting process by which the liquid metal at temperatures above 2000° F. is drawn by vacuum into dies to form castings of unusual strength. The alloy consists of 89% Cu, 10% Al and 1% Fe, has a hardness of 140 Brinell and 85,000 lbs./in.^{2} tensile strength. By reheating the casting to 1700° F. and quenching in water, the hardness can be increased to 260 and tensile strength to 100,000 lbs./in.^{2}. Shapes and making of the dies are described. Ha (3a)

Making Strong Brass and Making Brass Strong. MICHAEL G. CORSON. *Metal Industry*, N. Y., Vol. 33, Mar. 1935, pages 86-88. Part 1 of a series of articles. Old data as to characteristics of the cast brasses are of little value. Most frequently the melts contained gases and they were liberated during solidification. Sand cast metal is weaker than chill-cast, but it is wrong to conclude that this is due to the chilling effect, small grain, etc., in the chill cast specimen. Cast metal must be weaker and less ductile than the wrought and annealed metal. Unfavorably shaped bodies can be cast properly if the molten metal contains little or no gases. Castings are weak in corners and the remedy consists in using well rounded corners. PRK (3a)

3b. Ferrous

C. H. HERTY, SECTION EDITOR

Should Fine-grained Castings Be Produced by Proper Burden or by Overheating? (Soll man feinkörniges Gussgefüge durch richtiges Gattieren durch Ueberhitzen erzeugen?) B. OSANN. *Giesserei*, Vol. 28, Feb. 15, 1935, pages 76-78. To produce cast iron of fine-grained structure the melt must have no scum when pouring and the ratio of Si to C must be correct. A fine-grained, eutectic Fe is made by adding 15-20% steel scrap to the usual foundry pig iron with 3.4-3.5% C. The proper Si-C ratio can be taken from tables (e.g. of the author, see *Giesserei*, 1931, page 373). It is not recommended to produce fine grain by overheating as beginning at 1450° C. a transformation occurs in which the layer of ferric oxide Fe_3O_4 covering the melt dissociates into $3FeO + O$, and O is readily absorbed by Fe forming ferrous oxide which reacts with C forming CO. This can cause the excess C to form a scum which in its turn can give the nuclei for a secondary graphite segregation with a resultant coarser grain. Wall-thickness sensitivity can be avoided by using a eutectic liquid pig iron, i.e. an iron which does not contain either scum or cementite crystals. This is best obtained by using charcoal pig iron which it is recommended to produce again to avoid complications. Ha (3b)

Discussion of Certain Difficulties Met with in the Manufacture of Steel Castings (Considérations sur certaines Difficultés rencontrées dans la Fabrication des Pièces en Acier moulé). GEO. DELBART. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, Dec. 1934, pages 561-570. The reasons for and prevention of defects in steel castings, such as pipes, gaseous and solid inclusions, and cracks in molds, and the arrangements in molding, are discussed and examples of unusual castings shown. 12 references. Ha (3b)

Investigations into the Metallurgy of the Acid Open-Hearth Process (Untersuchungen über den metallurgischen Verlauf des sauren Siemens-Martin-Verfahrens). P. BARDENHEUER & G. THANHEISER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf,* Vol. 16, No. 17, 1934, pages 189-200. The changes in concentration of bath and slag were experimentally investigated in 3 acid open-hearth melts with solid and 2 with liquid charge. All melts showed a strong Si reduction while Mn content changes only in the beginning but remains constant later in the process. Also the contents of Cr, Ni, Mo, P and S do not change to any extent. The O content remains very low during the whole duration and is considerably below the values which could be expected according to the ferrous oxide content of the slag; the greatest part of O in the solidified samples was bound to Si. N content decreased considerably in the melts with solid charge while in those with liquid charge little or no change occurred; the former melts showed also much higher N content at the beginning of melting than the latter. SiO_2 content of the slag increased in all melts to about 57%. Fe exists in the slag mostly as ferrous oxide; the total content of ferrous oxide varies largely, from about 36-38% at the beginning to 9-23% at the end of the melt. With increasing duration of the melt the manganous oxide content of the slag decreases, Cr is found in various amounts while Ni and Mo were hardly found in the slags. Mn and Si reactions tend to an equilibrium at the beginning of the melt corresponding to that of the pure system, later the equilibrium is disturbed by the C content of the melt. The high reaction velocity of C removes O faster from the melt than can be resupplied from the slag. Viscous slags often form a layer of solid SiO_2 between melt and slag which impedes the reactions between melt and slag. At the end of the melt, the Si reactions determine, therefore, almost alone the velocity of decarburization. 14 references. Ha (3b)

Occurrence of Blisters in Tinplate. T. C. GREY-DAVIES. *Blast Furnace & Steel Plant,* Vol. 22, Dec. 1934, pages 702, 713-714; Vol. 23, Jan. 1935, pages 69-70. From *Sheet Metal Industries,* Vol. 8, Sept. 1934, pages 507-509, 514. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 558. MS (3b)

Regulation of Cupola Furnaces (Réglage de Cubilots). G. HÉNON. *Usine,* Vol. 44, Jan. 10, 1935, page 34. General discussion of influence of proper utilization of fuel and air regulation on the cast Fe produced. During the melting process in the cupola furnace, losses in Si amount to about 8-10%, in Mn 10-15%. P remains practically constant, S increases slowly; the Fe becomes the more sulphurized the less fluid the slag is. The wear of the refractory lining is the less the shorter the melting time and the more Si is used; it is recommended to charge as much Si as lime flux, the Si content of the coke must be taken into account. The operation of a cupola should always be guided by the requirements of obtaining a good melt rather than by molding operations; the quality of the castings deteriorates if the melt is held too long in the cupola. Ha (3b)

Open-Hearth Practice. *Blast Furnace & Steel Plant,* Vol. 23, Jan. 1935, pages 35-36. Among developments in 1934 were increased interest in furnace insulation, new designs of checker brick, careful supervision of teeming practice, improved quality of steel through metallurgical control, and improved refractories. MS (3b)

The British Cast Iron Research Association. *Foundry Trade Journal,* Vol. 51, Nov. 8, 1934, pages 293-298. The most important developments during the year are discussed. It has been possible to evolve a process in which, by a suitable addition to the metal and a comparatively simple after-treatment while molten, it is practicable on a laboratory scale to secure graphite in the extremely divided supercooled form, regardless of the original total-carbon content. AIK (3b)

New Wheel Foundry Growing Within Old One. *Iron Age,* Vol. 134, Dec. 27, 1934, pages 11-13. Discusses the construction of a wheel foundry on the site of the original plant by the Griffin Wheel Co., without interrupting production in the old plant. (3b)

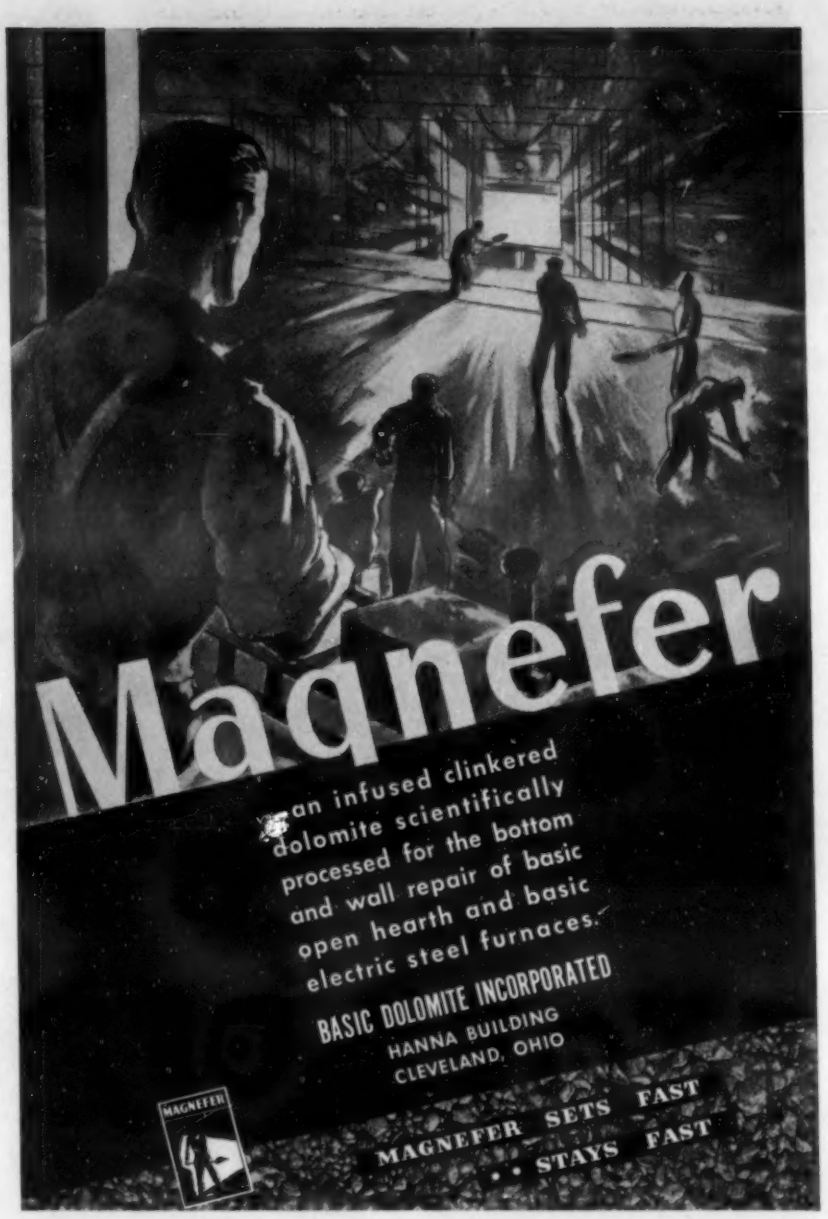
Steelwork's Executives Study All Factors of Operation. *Steel,* Vol. 96, Jan. 7, 1935, pages 170, 172, 286-288. Survey of progress in steel making during 1934. MS (3b)

High-Duty Cast Iron in the Foundry. GEORGE HALL. *Foundry Trade Journal,* Vol. 52, Jan. 17, 1935, pages 57-58. Paper read before the West Yorkshire branch of the Institute of British Foundrymen. High Si irons, Ni iron, Perlit iron, sand for Perlit iron, etc. are discussed. AIK (3b)

Determination of Oxygen in Alloy Steels and its Effect upon Tube Piercing. NEWELL HAMILTON. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 111-125. Includes discussion. See *Metals & Alloys,* Vol. 5, July 1934, page MA 320. (3b)

Some Problems of the Physical Chemistry of Steel Making. P. HERASYMENKO & E. VALENTA. *Transactions American Foundrymen's Association,* Vol. 5, Dec. 1934, pages 21-47. A number of formulae for equilibrium constants and reaction rates for steel making process are given and results reported obtained from research in which these formulae were used. Some rather novel ideas of deoxidation and mechanism of gas formation are set forth. In liquid condition, at temperatures around 2900° F. the Si, Mn, and FeO exist in the steel in equilibrium without any reaction and therefore, there is no gas evolution. Cooling the liquid to freezing point does not upset equilibrium; with further cooling of the steel the equilibrium is upset. The FeO is concentrated, appearing at certain points in the metal in the form of oxidic inclusions (silicates). This concentration brings about a different relation between the C and FeO so that reaction takes place with the liberation of gaseous CO which may be trapped in the partly solidified steel. The authors discuss both steel made in the acid open-hearth and in the basic electric furnace. Tests were carried out on C-steels (0.18 to 0.40%C.). 13 references. CEJ (3b)

The Effect of Deoxidation on Some Properties of Steel. C. H. HERTY, JR. *Transactions American Society for Metals,* Vol. 23, Mar. 1935, pages 113-125. Paper read and discussed at A.S.M. Convention, 1934. Previously abstracted from Preprint 19, 1934. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 514. WLC (3b)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Critical Studies of a Modified Ledebur Method for Determination of Oxygen in Steel, II. T. E. Brower, B. M. Larsen & W. E. Shenk. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 61-81. Includes discussion. See *Metals & Alloys,* Vol. 5, Aug. 1934, page MA 389. (3b)

Indian Foundry Production. William T. Bruce. *Foundry Trade Journal,* Vol. 51, Dec. 20, 1934, pages 387-391. Abstract from a paper read before the Edinburgh Section of the Institute of British Foundrymen. The quality of Indian molder production of the vertically cast cast iron pipes, cast iron pile cylinders and screws, cast iron sewage, water and gas pipe fittings, etc., are discussed. AIK (3b)

Future Problems in Ferrous Metallurgy, The Soda Ash Process. Colin Duncombe Abell. *Foundry Trade Journal,* Vol. 51, Sept. 20, 1934, pages 175-176. Author concludes: (1) use of soda ash results in degasification of the metal, (2) in using soda ash at least 10% of its weight of finely ground charcoal would be an advantage, (3) best results should obtain using a finely ground mixture of 80% sodium meta-silicate, $Na_2O.SiO_2$, and 20% calcium meta-silicate, $CaO.SiO_2$, plus 10% of its weight of ground charcoal. Thicken up with ½-¾ of its weight of ground limestone, (4) superheating safe when ladle method is adopted, (5) for cupola work no more than equal weight of lime to soda ash should be used, (6) for cupola work a slag corresponding to one of the following should be used, preferably the first with a lining as shown in (7) below:

Na_2O	Al_2O_3	SiO_2
51.50%	—%	48.50%
17.50	5.40	77.10

(7) best daub for ladles should be composed of about 5 parts ground laterite to one part clay, (8) the refining effect upon the graphite by the soda-ash process is due to a partial solution of C as Mn carbide and partly to a slight loss in C, (9) control of the total C content of cast irons may be effected as the use of high-alkali type of slag is extended. CEJ (3b)

Mass Effect and Quality in Steelmaking. Size and Design of Hearths. John H. Hruska. *Foundry Trade Journal,* Vol. 51, July 19, 1934, pages 47-50. Abstract of article appearing in Iron Age. See *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 434. CEJ (3b)

Steel Castings. W. H. Hatfield *Engineer,* Vol. 158, Oct. 26, 1934, pages 419-421; *Engineering,* Vol. 138, Nov. 9, 1934, pages 511-512; *Iron & Steel Industry,* Vol. 8, Nov. 1934, pages 49-52; Dec. 1934, pages 89-94. An exchange paper from the Institute of British Foundrymen to the American Foundrymen's Association. See *Metals & Alloys,* Vol. 6, Mar. 1935, page MA 95. LFM + CEJ (3b)

Defects in Iron Castings: Their Cause and Cure. T. Tyrie. *Foundry Trade Journal,* Vol. 52, Jan. 17, 1935, pages 59-62; Jan. 24, 1935, pages 77-80. Paper read before the Scottish branch of the Institute of British Foundrymen. Is confined more or less to small and medium-weight general engineering castings, such as produced on a repetition basis, but with few exceptions the general findings can be applied to heavy work. Mold and core faults, core breaking, blow holes, slag holes, metal faults, different types of inclusions, etc., are discussed. AIK (3b)

Nonmetallic Inclusions in Steel. Part I. Products of Deoxidation. Stephan F. Urban & John Chipman. *Transactions American Society for Metals,* Vol. 23, Mar. 1935, pages 93-112. Paper read and discussed at A.S.M. Convention, 1934. Previously abstracted from Preprint 21, 1934. See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 4. WLC (3b)

Most Favorable Shape of Converter in the Thomas Steel Works (Beitrag zur Frage der günstigsten Konverterform im Thomas-Stahlwerk). T. Heyden. *Mitteilungen aus dem Forschungs-Institut der Vereinigten Stahlwerke Aktiengesellschaft, Dortmund,* Vol. 4, Oct. 1934, pages 161-188. See "Studies on the Most Favorable Form of the Basic Bessemer Converter," *Metals & Alloys,* Vol. 6, Mar. 1935, page MA 92. Ha (3b)

Inverse Segregation in Cast Iron (A propos de la "Trempe inverse" de la Fonte). M. Girardet. *Revue de Fonderie Moderne,* Vol. 29, Feb. 25, 1935, pages 47-48. After reviewing literature on cause of and remedy for inverse segregation in cast iron the author believes that the heterogeneity theory gives the best explanation which, at the same time, suggests also the remedy to adopt, i.e. to eliminate all causes which could favor solidification as white cast iron. 6 references. Ha (3b)

Coke in the Foundry Cupola (Koks im Giessereischachtofen). W. Hollinderbäumer. *Giesserei,* Vol. 28, Feb. 15, 1935, pages 73-75. The effect of the quality of coke on the melting process was studied. The melting process in the foundry cupola requires a tough, firm coke. The toughness of a coke is influenced by the carbonizing period. The size of the coke pieces is of only little importance for the melting process, which is contrary to most views found in literature. Of great importance for the melt however, is the construction and manner of building of the cupola. The appearance of a coke does not permit judging its quality. Ha (3b)

Carbon Control for Cupola Melting. J. L. Francis. *Foundry Trade Journal,* Vol. 51, July 26, 1934, pages 55-56. Structure of coke is of fundamental importance. Regulation of the weight and quantity of coke charged for the bed is important. The greater the speed of melting and removal of the molten iron from contact with incandescent coke the less is the C pick-up likely to be. Volume and pressure of the blast must be controlled. Reduction of C may or may not be possible by use of steel scrap. CMS (3b)

Basic Open-hearth Bottom-cast Practice and Iron-Oxide Control. W. J. Reagan. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 113, 1934, pages 42-60. Includes discussion. See *Metals & Alloys,* Vol. 5, June 1934, page MA 251. (3b)

4. WORKING

Treatment of the Workable Aluminum Alloys in the Shop (Behandlung der knetbaren Aluminiumlegierungen in der Werkstatt, insbesondere bei der spanlosen Formgebung). G. Eckert. *Aluminium,* Vol. 17, Jan. 1935, pages 11-12. Instructions for cold- and hot-working, temperatures for intermediary annealing (generally between 350° and 450° C.), admissible diameter for bending sheets, profiles and tubes are given for a number of Al alloys now in common use. Ha (4)

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Roll Pass Design. I and II. W. Trinks. 2nd Edition. Penton Publishing Company, Cleveland, 1933-4. Cloth, 6¼ x 9¼ inches, Vol. I, 201 pages, Vol. II, 228 pages. Price $4.65 and $6.00 respectively.

This two volume treatise, by Professor Trinks, is the only comprehensive work on the subject, available in English, and based upon American practice.

Written by an engineer of wide experience, and broad outlook, it should fill the need, both as an introduction to the subject, for those who may intend to follow the practice of the art of roll design, and as an exposition of the principles behind the art of roll design, for the manager, superintendent, engineer, and others, to whom the results of rolling operations are of importance.

For the purposes for which this book is intended it is probable that it has greater practical value than it would have if written by a practicing roll designer. In the latter case the book might have greater and more accurate detail, but written from the standpoint of the practical roll designer, it would presumably omit many of the fundamentals, which although axiomatic to one skilled in the art, are quite necessary to lay the groundwork for an understanding of the subject, by one less intimately associated therewith.

The first volume treats of the underlying engineering principles upon which the design of the roll, as a structure, as well as the design of the roll pass itself, is based.

The second volume is a study of the rolling of different sections, in most cases taken from actual examples, with particular reference to the application of the principles of Vol. I.

The first volume, as stated in the preface, is an exposition of underlying principles, both elementary, and more advanced, and as such, is to be taken as the first step towards building up a theory of roll pass design. That such theory, at the present time, is fragmental and incomplete is acknowledged, but it will serve to elucidate the reasons for roll pass design as actually practiced. Chap. I studies the forces acting between the roll and the stock, during the rolling process, the stresses set up, and the deformations produced thereby, both in the rolls proper, and in the structure of the rolling mill. Chap. II studies the principles governing the entrance of the bar into the pass, and the deformation of the work piece within the pass. Chap. III discusses other principles involved in rolling, such as forward slip, or extrusion effect, the determination of the pass line, and its relation to the pitch line. Consideration is given to non-uniform reductions and their effect upon the section rolled, (pulling down or crippling of the flanges), their effect upon the direction of delivery, and the use of side guides to secure a straight delivery.

The second volume treats of the actual design of roll passes, and is therefore, a record of past performances rather than a study of proposed methods. As pointed out by the author, however, "A serious attempt has been made to keep this volume above the level of a mere collection of pass drawings, by pointing out the underlying theoretical and practical reasons for the shape and size of the passes." Chap. I describes and illustrates the shape of the roll passes for rolling such nearly square sections as blooms and billets. The passes are illustrated for two high reversing mills, three high mills, and continuous mills, in the latter case particularly for small billets from 4" square down to 1¼" square. Chap. II treats of the design of passes for the rolling of flat, or oblong sections, starting with the rolling of slabs on blooming and slabbing mills. It passes logically to the rolling of semi-finished flat sections, sheet bars and tin bars, and thence to the rolling of finished flats. The various systems of flat and edge, and of tongue and groove rolling are considered. Chap. III discusses the rolling of Merchant Bars, so called, hexagons, rounds, etc. The rolling of rounds, either by the hand round method, or by guide, is taken up in considerable detail, as its importance warrants. Following is a brief discussion of rapid reduction passes, such as are used in wire rod mills, and mills for the production of the smaller bar mill sizes. Chap. IV comprises 63 of the 228 pages of the volume, and treats of the rolling of shaped sections. This is the part of roll designing requiring the greatest skill and experience, and as would be expected, shows the widest variation in the methods employed. Chap. V treats of die rolling, or as otherwise termed, periodic or deformed rolling, in which the shape of the finished section is not the same throughout its length, but changes periodically throughout a length equal to, or a fractional part of, the roll circumference. Die rolling requires that consideration be given to many factors that in ordinary rolling may safely be neglected, or roughly approximated. Among these factors are: the extrusion effect, and the effect of roll spring. Chap. VI treats of the determination of the torque, and power requirements for rolling. It recites and comments upon the various factors affecting this determination, and may be briefly summarized.

An appendix to this volume treats briefly of the rolling of copper, brass and bronze, in the shape of bars, and of aluminum in structural shapes. A second section to the appendix treats of the piercing and rolling of seamless tubes.

To sum up we may very well quote the author in his preface to the first edition: "Nobody can become an expert roll designer solely by reading this or any other book.—What the book is intended to do, and can do, is to help a roll designer to do his work better and more intelligently."

I believe this to be true but I also believe that the greatest value of the work is to the manager, and the engineer, in teaching them what is occurring within the roll pass, and thereby, enabling them to approach the general problem of mill design and operation from a broader standpoint than would otherwise be the case. Stephen Badlam (4a)—8—

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Manufacture of Seamless Tubes. Ferrous and Non-ferrous. GILBERT EVANS. H. F. & G. Witherby, London, 1934. Cloth, 7½ x 10 inches, 187 pages. Price 40 s.

In the Foreword the author states that the volume was compiled as the result of a chance remark by the Technical Librarian, Birmingham, Eng. Central Libraries suggesting the need of a work or treatise that would completely cover every branch of the seamless process. The author has wisely refrained from claiming that he has accomplished so great a task. The various phases of the subject have been dealt with for the layman informatively and to some extent historically and descriptively but by no means technically or completely. In the ferrous section one chapter is devoted to patents and developments, one to piercing, rolling, reducing and hot drawing and other chapters to finishing, testing, reheating furnaces and to general observations. The author makes the statement, interesting in view of recent developments in the art, that small sizes of pipe, already made to some extent by seamless processes, may increase in use due to popular demand and the ability of manufacturers to produce at costs comparable with those of welded processes.

In the section devoted to non-ferrous seamless processes, the author starts with the manufacture and preparation of the billets and follows with a chapter on piercing by rotary and extrusion methods. Reheating furnaces and a brass shell casting foundry are described and illustrated. As would be expected, considerable space is allotted to cold drawing and to annealing and pickling. The business and organization features of seamless tube manufacture are given some attention.
George Snyder (4a)-B-

The Variation of Substance in Tinplate. J. SELWYN CASWELL. *Iron & Steel Industry*, Vol. 8, Dec. 1934, page 99. Abstract of paper read before the South Wales Institute of Engineers. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. (4a)

The Modern Method of Manufacturing Sheet Steel. ERIC R. MORT. *Iron & Steel Industry*, Vol. 8, Dec. 1934, pages 79-84. In America the evolution of the wide strip mill has completely revolutionised the sheet and tinplate industries. Author discusses the applicability of this new method of manufacture to practice in Britain. Author concludes that the conditions in Britain are rather different from those in the United States and any strip installation would be one with as low a tonnage capacity as possible consonant with low operating and installation costs. A 48" hot mill comprising one universal rougher plus one 4-high finisher would have an annual capacity of well over 200,000 tons of steel and, if it could be operated near to capacity, strip 0.15" thick could be produced at a cost only slightly more than that of sheet-bar. Part of this tonnage could be cold-rolled on single-stand reversing mills to sheets and tin-plate, part could be disposed of to sheet and tin mills as "breakdowns" and part could be sold as plates. One hot and cold strip mill could be arranged to roll all grades of sheet and tinplate of better quality than that produced in Britain at present, and at a cost wholly impossible with the old-time mills. CEJ (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

6

Forging Certain Copper Alloys. E. BERTHELMAN. *Heat Treating & Forging*, Vol. 21, Jan. 1935, pages 24-28. From *Metallurgia*, Vol. 11, Dec. 1934, pages 45-48. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 96. MS (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

7

Deforming Conditions in Wire-Drawing (Die Verformungsverhältnisse beim Drahtziehen). E. SIEBEL. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 20, 1934, pages 213-216. The deformations occurring during the wire-drawing process were studied on divided Cu rods on which a scale was etched. Core and external zones become denser in different degrees. The actual conditions are illustrated in photographs and curves.

8 Ha (4c)

Stresses and Flow of Material in Tube-Drawing (Spannungen und Werkstoffluss beim Rohrziehen). E. SIEBEL & EBERHARD WEBER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 20, 1934, pages 217-224. Distribution of stresses and conditions of friction in various seamless tube-drawing processes were experimentally investigated. The results can be used to determine the original dimensions a tube must have to be drawn to a given final dimension by pressure-drawing.

9 Ha (4c)

4d. Machining

H. W. GRAHAM, SECTION EDITOR

10

Carbide Tools on Non-ferrous Metals. F. A. WESTBROOK. *American Machinist*, Vol. 79, Feb. 13, 1935, pages 179-180. Boring of non-ferrous metals with tungsten carbide tools resulted in a better finish, greater accuracy and better economy due to saving in time and elimination of rejects. Examples are described. Ha (4d)

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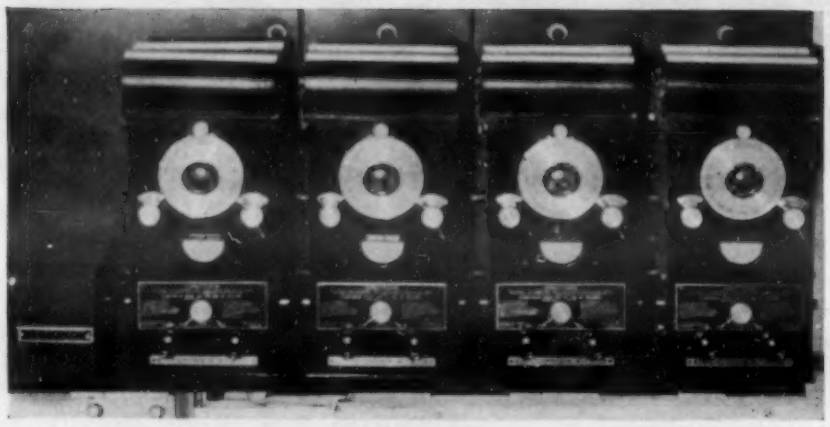

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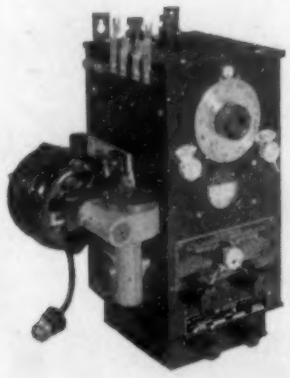

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5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

1

Heat-treatment of Hardenable Aluminum Cast Alloys (Die Wärmebehandlung der vergütbaren Aluminiumgusslegierungen). E. Söhnchen. *Giesserei*, Vol. 28, Mar. 1, 1935, pages 100-108. Precipitation hardening of binary and more complex Al alloys is discussed and the factors influencing it reviewed. Heat-treatment must be varied according to grain size. Space diagrams show the relation between grain size, duration of annealing and hardness of several industrial Al alloys. Temperature sensitivity, grain growth, and the possibility to influence and accelerate precipitation hardening by magnetic-electric treatment, are discussed and other investigations reviewed. 26 references. Ha (5)

2

An Investigation of Equilibrium Diagrams of Salts for Salt-baths; Part V. The Equilibrium Diagram of the $BaCl_2$-$CaCl_2$-KCl System. Tomo-o Satô & Teiichirô Amano. *Kinzoku no Kenkyu*, Vol. XI, Nov. 20, 1934, pages 549-560. Thermal analysis was carried out on binary and ternary mixtures of salts, $BaCl_2$, $CaCl_2$ and KCl. The binary equilibrium diagram of the $CaCl_2$-KCl system was constructed; in this system, a compound, $CaCl_2$.KCl, which has a definite melting point at 760° C. is formed. The compound forms eutectics with KCl and $CaCl_2$, the eutectic points being 655°, 25 mol % KCl and 615°, 76 mol % KCl, respectively. The diagram constructed in the present study almost coincides with that of Menge. From the result of the thermal analysis of 59 ternary mixed salts, isothermal diagrams, sectional diagrams and a projection diagram of the space model of this ternary system were constructed. This ternary system is divided into 3 parts of ternary systems, $CaCl_2$-$CaCl_2$.KCl-$BaCl_2$, $CaCl_2$.KCl-2KCl.$BaCl_2$-$BaCl_2$, and $CaCl_2$.KCl-KCl-2KCl.$BaCl_2$, which form ternary eutectics, respectively. The ternary eutectic points of these systems are 543° (23 mol % $BaCl_2$, 58 mol % $CaCl_2$, 19 mol % KCl), 553° (26 mol % $BaCl_2$, 18 mol % $CaCl_2$, 56 mol % KCl) and 552° (21 mol % $BaCl_2$, 17 mol % $CaCl_2$, 62 mol % KCl), respectively. TS (5)

3

4

Drill-Steel Sharpening Practice. G. B. O'Malley. *Chemical Engineering & Mining Review*, Vol. 27, Feb. 8, 1935, pages 157-165. A critical analysis of general Australian steel-shop practice from the metallographic aspect, and some suggestions for the modification of the existing routine to conform more nearly with accepted methods of correct heat treatment. Numerous photomicrographs are shown, present bit forging, hot milling, bit hardening and shank forging and hardening processes described and criticized. The outstanding points of divergence from correct metallographic procedure are: (1) lack of temperature control in forging and hardening with a marked tendency towards overheating, (2) the use of forging dies beyond their economic limit of usefulness, and consequent misuse of the hot miller to supplement the work of the sharpener, (3) incorrect conditions in bit quenching, concerning chiefly the depth of immersion and the temperature of the water, (4) incomplete hardening of shanks and failure to remove the overheating effects incidental to forging, (5) inordinate heating in the various accessory operations in the shop. Corrosion-fatigue is the outcome of factors apart from the steel-shop and relief is found in the use of superior steels of the stainless-liner type. WHB (5)

5

6

The Heat Treatment of Steels in Controlled Atmospheres. A. G. Robiette. *Iron & Steel Industry*, Vol. 8, Dec. 1934, pages 109-114. In cases where there is a full appreciation of the conditions influencing the reactions between the metal and the surrounding atmosphere very gratifying results of heat treatment of steel in a protective atmosphere are possible. Characteristics of H, N, and anhydrous NH_3 are pointed out. Various types of furnaces applicable to this use are described. Process may be applied to many cases, e.g. fine wire, thin strip, light-gage sheet, pressings and other manufactured parts. Pure H is the most suitable gas for annealing stainless steels. The author predicts that most of the electric furnace operations carried out at present in natural oxidizing atmospheres will be done more economically in the future under the influence of a protective gas. CEJ (5)

7

Some Factors Governing the Heat-Treatment of Aluminium Alloys. J. Towns Robinson. *Metallurgia*, Vol. 11, Mar. 1935, pages 129-132. The material to be treated should be of high quality and temperatures should be closely controlled. Hardening phenomena in different Al alloys are discussed. JLG (5)

8

What a Shop Executive Should Know about the Heat Treatment of Cutting Tools. R. C. Deale. *Machinery*, N. Y., Vol. 41, Mar. 1935, pages 401-403. The controlling influences of heat treatment, i.e., furnace atmosphere, heating temperatures and tempering methods, are discussed at length. Ha (5)

Heat Treatment in Controlled Atmospheres Including Gaseous Carburizing. C. R. Austin. *Transactions American Society for Metals*, Vol. 23, Mar. 1935, pages 157-186. Paper read and discussed at A.S.M. Convention 1934. General discussion of application of atmospheres for control of oxidation and decarburization in batch type furnaces. Materials discussed include high and low carbon steel, stainless steel, Cu, brass and Si steel. WLC (5)

9

Heat Treatment and Metallography of Steel. H. C. Knerr. Published by the author, Temple University, Philadelphia, 1935. Loose-leaf in binder, 8½ x 11 inches, 161 pages. Price $3.50.

This text on the element of the physical metallurgy of steel originally published serially in Forging, Stamping and Heat-Treating has been in use for some ten years at Temple University. Since the principles dealt with are still valid, only minor changes have been made in this edition, which is now available for public sale. New sections are planned, and the loose-leaf binding will accommodate them when issued.

10

The absence of references to recent literature makes the book of limited value as a source of information to one wishing to go into detail on a particular phase, but as an introduction to the fundamentals, this omission is not very serious. The book is a good first text for college use, or home study.
H. W. Gillett (5)-B-

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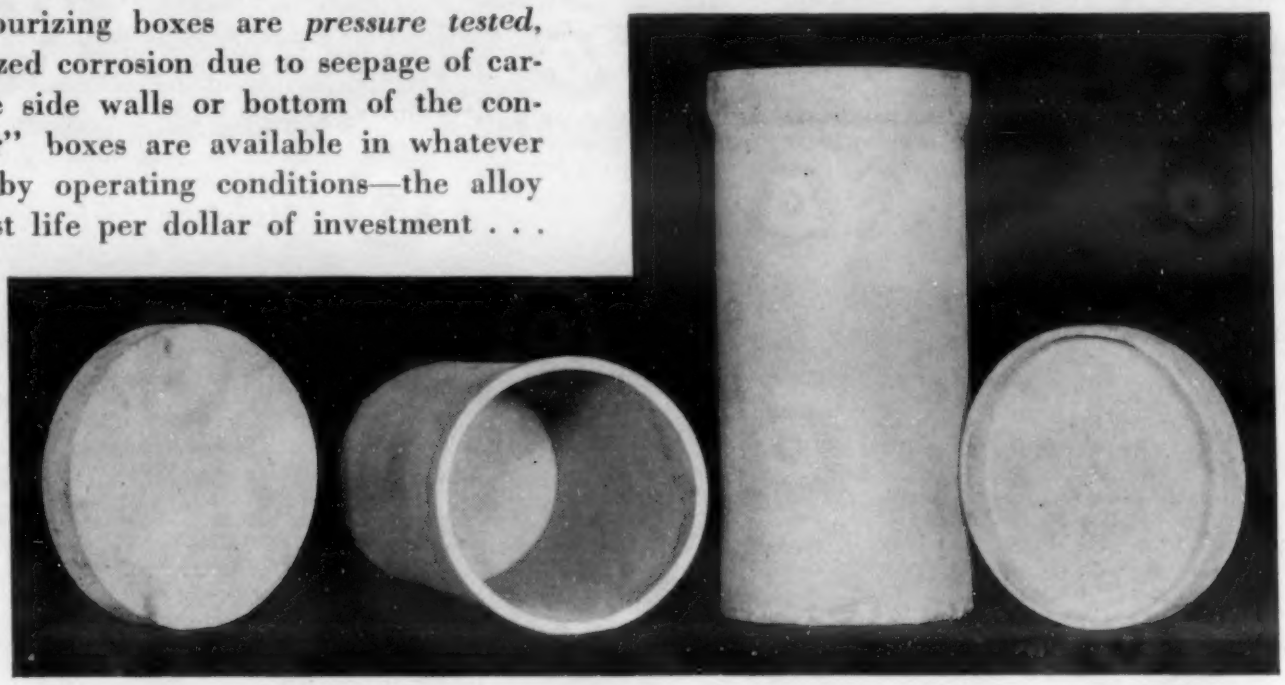

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Hardening in Electric Furnaces (Aus der Praxis der Vergütung in Elektroöfen). W. Prutz. *Elektrotechnische Zeitschrift*, Vol. 56, Jan. 3, 1935, pages 11-13. Qualitative and quantitative results of a great number of electric furnaces of different types for hardening, annealing and other kinds of heat-treatment are described; particular attention is paid to temperature distribution, atmosphere, and cooling of quenching liquids. Ha (5)

5a. Annealing

Influence of Annealing on the Quenching-Hardness and Coercive Force of Tungsten Magnet Steel. Gisho Kojima. *Kinzoku no Kenkyu*, Vol. 12, Feb. 1935, pages 79-88. In Japanese. It is already known that the η-phase in tungsten steel readily changes to the stable carbide WC on annealing at high temperature, and the carbide so formed is almost insoluble in austenite at temperatures not far above the critical range. It is consequently considered, that by annealing the W steel the amount of the dissolved C in the austenite is decreased and the quenching effect is reduced. The influence of annealing on the quenching-hardness and the coercive force of W magnet steels (0.50% C, 5% W, and 0.75% C, 6% W) were studied. The quenching-hardness is minimized by annealing at 900°, the highest value being obtained for the steel annealed at 1000° as compared with the steels annealed at 850° or 800°. The highest value of coercive force was obtained for the steel quenched from 900° after being annealed at 1000° among the steels subjected to the following heat-treatments, (1) quenched from 775°, 800°, 850°, 900°, or 950° after being annealed at 1000°, (2) quenched from 775°, 800°, 850°, 900° or 950° after being annealed at 850° and air-cooled, or (3) quenched from 775°, 800°, 850°, 900° or 950° after being annealed at 800° and slow-cooled. It is deduced from the results of the investigation that the most suitable heat treatment for obtaining the highest coercive force of the tungsten magnet steel is to anneal the steel at 1000°and then to quench from 900°. KT (5a)

5b. Hardening, Quenching & Drawing

Quenching in Water, Brine and Oil. I. N. Zavarine. *Metal Progress*, Vol. 27, Apr. 1935, pages 43-46. An instantaneous illumination obtained from a spark of high intensity from the discharge of a condenser was used for photographing the reactions which take place between steel being quenched and the medium. These pictures show that water and oil behave similarly in that a continuous film of vapor surrounds the piece which is in continuous motion, breaking and forming in a wave like manner. This film in case of water is thinner and in faster motion due probably to lower viscosity than the oil. In brine and caustic solutions the behaviour is quite different in that as soon as the heat of the piece evaporates water salt is deposited and leaves the hot metal with explosive violence effecting violent agitation of the medium which gives brine quenching its higher velocity. WLC (5b)

Transformation of Austenite in Chromium Steel (Etude sur les transformations de l'austénite dans un acier au chrome). S. Steinberg & V. Zuzin. *Revue de Métallurgie*, Vol. 31, Dec. 1934, pages 554-559. Samples of 2% C, 12% Cr steel were quenched in lead at 500° C., placed hot into a magnetometer preheated to the temperature and cooled 20° C./min. Rise in quenching temperature lowers the temperature of martensite transformation. At room temperature the steel contains 20% austenite after quenching from 900° C. and 100% austenite after quenching from 1150° C. The intensity of quenching affects the amount of residual austenite. On quenching from 1150° C. in water 29% austenite is produced, in oil 32%, and in air 36%. Soaking at the quenching temperature likewise increases the amount of austenite. Specimens quenched from 1050° C. in a lead bath kept at 500° C. were kept at a constant temperature within the range of 650° to 150° C. for different lengths of time. Magnetic testing showed a full decomposition of austenite on heating for 15 minutes in the range 500°-600° C. Austenite was very stable in the range 350°-400° C.; heating for 20 hours did not decompose it at all. Between 350° and 200° C. the stability decreases reaching a minimum at 300° C. Decomposition cycle at 300° C. is accomplished in 10 hours, but only ⅓ of the austenite is decomposed at the end of the cycle. Heating above 500° C. decomposes all austenite, heating between 350° and 200° C. only ⅓ of it. Partial transformation of austenite in the range above 500° C. raises Ar″ point by precipitation of the carbides from austenite. In the lower heating ranges it lowers the temperature of martensitic transformation. Heating for 20 hours at 250°-300° C. lowers Ar″ point, for example, from 180° C. to 100° C. In order to obtain this lowering some decomposition of austenite should take place. 13 graphs of decomposition are given. JDG (5b)

Production and Heat Treatment of Springs. J. B. Nealey. *Industrial Heating*, Vol. 2, Mar. 1935, pages 135-138. Equipment and procedure for forming and heat treating of coil and elliptic springs are described in full. Ha (5b)

5e. Carburizing

Catalytic Decarburization of Iron and Steel. Masami Kobayasi. *Kinzoku no Kenkyu*, Vol. 12, Feb. 1935, pages 101-119. In Japanese. From the point of view that the velocity of reversible reactions which take place in the ternary system consisting of Fe, C and O may be accelerated by the same sorts of catalysers, some experiments have been carried out with regard to the decarburization of cast iron and steel, using catalysers which were active toward the reduction of the iron oxides and cementation of iron, namely, carbonates and chlorides of alkali and alkaline earth metals. The results were as follows:—(1) The catalyser for reduction is also effective for decarburization. (2) The most effective catalytic effect was obtained by coating a round specimen with 0.035 g. CaO/cm.² of the specimen. (3) Chlorides of alkalis were more effective than the chlorides of alkaline earth. But too much of the catalysers is harmful for the decarburization. KT (5e)

6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Evaluation of a Formula for Calculating Heat Accumulators According to the Recuperator Method (Entwicklung einer Endformel für die Berechnung der Wärmespeicher nach der Rekuperatormethode. Ausgehend von den Berechnungen Schuhmachers). JULIUS LAMORT. *Feuerungstechnik*, Vol. 22, Jan. 15, 1934, pages 6-8; Feb. 15, 1934, pages 20-22; Mar. 15, 1934, pages 30-33. The formulae previously advanced by Schuhmacher *(Mitteilungen der Wärmestelle des Vereins Deutscher Eisenhüttenleute, No. 119)* are modified whereby the effect of the checker thickness is investigated in particular. The limiting values for the newly introduced equations are discussed critically and correction factors for very thin clay walls and for materials of higher thermal conductivities are given. The investigations of Schack on the effect of dust coatings on the efficiency of regenerators *(Bericht des Stahlwerksausschusses des Vereins Deutscher Eisenhüttenleute, No. 153)* are considered and the improvement of the factor K/K$_{ideal}$ (ratio of heat transfer in actual and ideal regenerator) is studied with reference to carborundum and magnesite and for cast Fe plates of 20 and 66.6 mm. thickness. WH (6)

Use of Automatic Control on Metallurgical Furnaces. A. J. BOYNTON. *Iron & Steel Engineer*, Vol. 12, Mar. 1935, pages 159-166. Paper read at Cleveland Meeting of American Association of Iron & Steel Electrical Engineers, Sept. 1934. Discusses phases of control and methods of gas producer control, pressure regulation, control of fuel flow and combustion or air control. WLC (6)

Theory and Practice of Immersion Heating with Gaseous Fuels. E. B. DUNKAK. *Iron & Steel Engineer*, Vol. 12, Mar. 1935, pages 167-172. Paper read and discussed at Cleveland Meeting of American Association of Iron & Steel Engineers, Sept. 1934. Discusses design and construction of gas fired immersion heaters for metallurgical furnaces used in tin plate work, melting of type metals, and salt baths for heat treating. Advantages claimed are fuel economy, better temperature control and heat distribution, longer container life, increased production and improved working conditions. WLC (6)

Tercod—A New Refractory Brick for Electric Furnaces. G. S. DIAMOND. *Transactions Electrochemical Society*, Vol. 63, 1933, pages 301-304. Includes discussion. See "New Silicon-Carbide Refractory Brick," *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 56. (6)

Automatic Control and Use of Fuels in Steel Mill Furnaces. A. J. FISHER. *Iron & Steel Engineer*, Vol. 12, Mar. 1935, pages 149-158. Paper read at Cleveland Meeting of American Association of Iron & Steel Electrical Engineers, Sept. 1934. Descriptive of blast furnace gas utilization and control for economy. WLC (6)

Pulverized Fuel in the Metallurgical Industry. J. H. MAHLER. *Iron & Coal Trades Review*, Vol. 130, Feb. 22, 1935, pages 329-330; Mar. 1, 1935, page 376. Includes discussion. Advantages over other forms of heating and some principal applications of pulverized coal to reheating and forging furnaces are reviewed, and savings to be effected are compared with hand firing and with oil. Unit pulverizing equipment is considered to be better than buying pulverized coal in bulk. Ha (6)

Physical Properties of Insulating Brick. WALTER C. RUECKEL. *Journal American Ceramic Society*, Vol. 18, Jan. 1935, pages 18-22. See *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 399. WB (6)

The Electric Melting of Cast Iron. A. G. ROBIETTE. *Metallurgia*, Vol. 11, Feb. 1935, pages 101-104. Points out advantages of electric melting and shows where electric furnaces are used in production of iron castings. JLG (6)

The Ramming of Linings of Rotary Furnaces. W. J. REES. *Bulletin British Cast Iron Steel Research Association*, Vol. 4, Jan. 1935, pages 86-87. Uniformity of moisture content and thorough mixing of the material used in forming the lining are required. Also for proper union of successive layers it is necessary to use a chisel-shaped ramming tool to force interconnection. WB (6)

Industrial Heating. HARRY A. WINNE. *Heat Treating & Forging*, Vol. 21, Jan. 1935, pages 40-41. Except for the part on photoelectric pyrometers, this is the same as article by Harry A. Wynne in *Industrial Heating*, Vol. 2, Jan. 1935, pages 25-26, 34. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 101. MS (6)

Pulverized Fuel Firing for Metallurgical Purposes. H. E. COOKSON. *Iron & Steel Industry*, Vol. 8, Nov. 1934, pages 53-55. Earliest trial was that by Niepoe in 1818. Pulverized fuel may be defined as any carbonaceous fuel passed through a preliminary crusher, the moisture reduced to as low a figure as possible, and subsequently ground to an almost impalpable powder in a special mill. Pulverized fuel is advantageous because in that state the intimate and almost complete mixture of fuel and oxygen can be effected in the correct proportions prior to ignition of the mixture, and so combustion is almost instantaneous and complete. The use of finely-divided solid fuels, allowing an intimate mixture with the oxygen necessary for combustion, ranks with gaseous fuels in efficiency. Classes of pulverizers include the impact, the ring, roller, and multiple ball types. Several types of installations for use of pulverized fuel are described. CEJ (6)

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FUEL CONSUMPTION—A meter applied to one furnace recorded an average gas consumption of 30 cubic ft. per hour.

PRODUCTION—Regularly forge from 6,000 to 8,000 valves in 8 hours.

CONCLUSION—Accepting 7,000 valves as an average production in 8 hours, 240 cubic ft. of gas are required. With an average fuel cost, overhead not included, of 50c per 1000 cubic ft., 7,000 valves are forged at a fuel cost of 12.5c. This is equal to a fuel cost of $0.000071 per pound of stock or $0.000018 per piece forged.

TAYLOR Refractory Insulating Brick and P.B. Sillimanite Air-Setting Cement used as standard construction of these furnaces for the past year and a half.

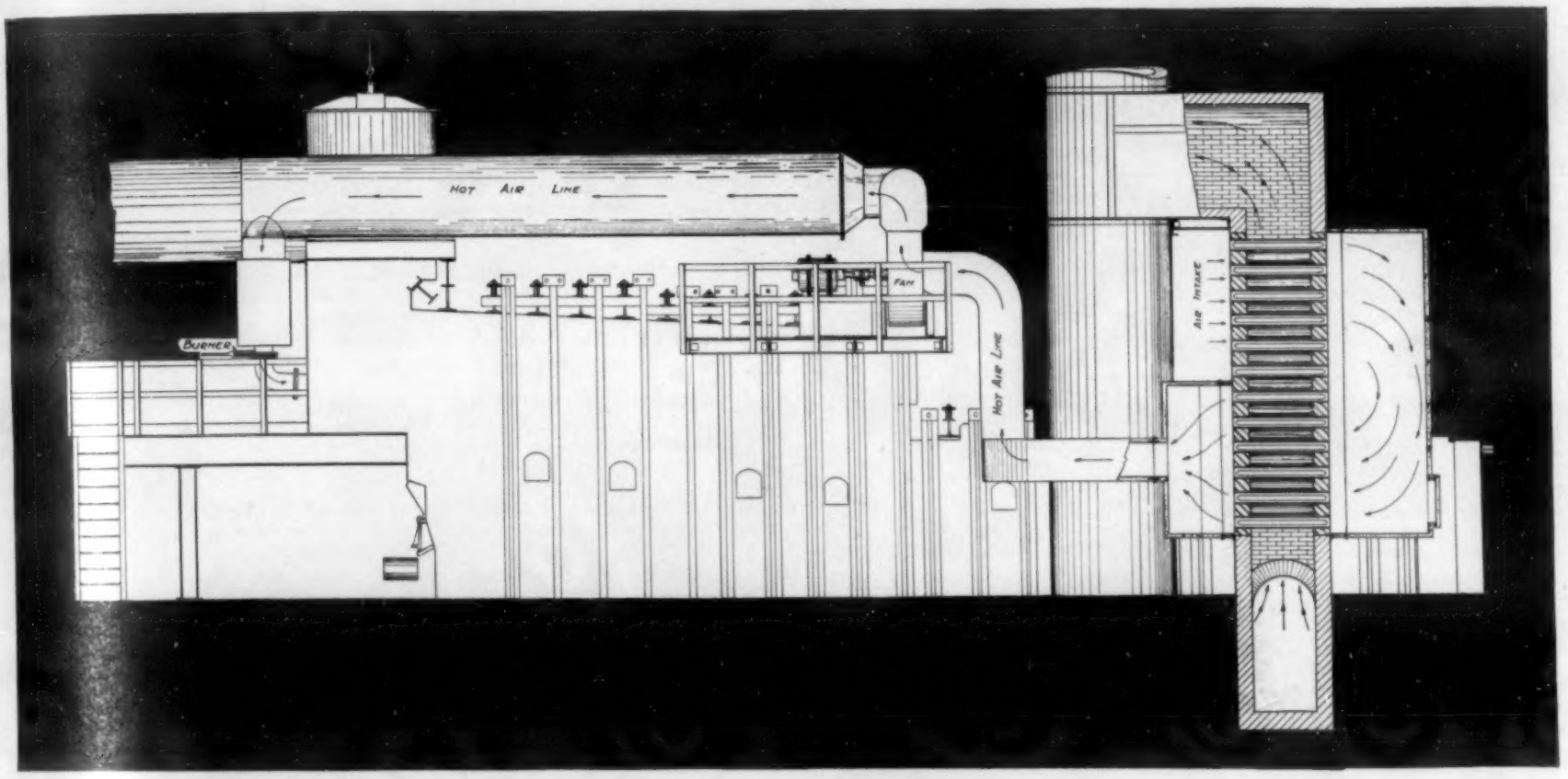
Write for your copy of "Refractory Insulating Brick." It is full of information you'll be glad to place in your file.

If this statement of facts means anything to you—and it should—get in touch with our Engineering Department—use our Consulting Service—it may mean a new day in production and profits for you.

THE CHAS. TAYLOR SONS CO.

CINCINNATI, OHIO

It is very easy to apply this Recuperator to present furnaces



A CASE in point is the recuperator layout for a producer gas fired, continuous billet heating furnace, as illustrated. Existing flues and stack are used. There is a decided saving in fuel, and of course money, in this installation. There are no changes in the furnace proper.

Add accessibility, ease and convenience in repairs, high efficiency, and durability and it is then easy to see why more and more operators of various types of furnaces have installed The Carborundum Company's recuperator.

Savings of 25% to 35% in fuel costs are not unusual, due to recuperation. The "Carbofrax" Tubes assure efficient heat recovery. They can withstand the severest of temperature conditions.

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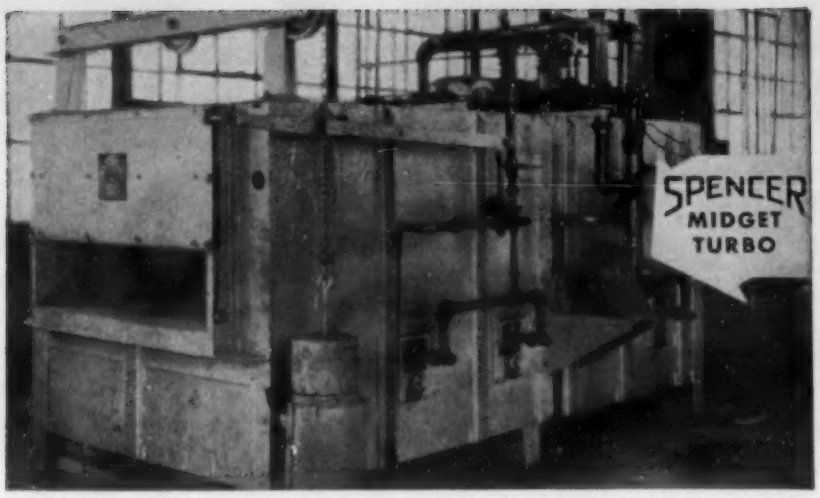

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For low-volume, intermittent service, you can have a Spencer "Midget" Turbo mounted directly on the equipment as shown above. The single-stage type also requires little space and is readily adapted to individual layouts with short piping connections.

For heavy and continuous service, Spencer Multi-Stage Turbos are made in a range of sizes that provide for either individual or battery operation of the air supply.

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TURBO-COMPRESSORS

S-12

1 **The Case for the Small Emergency Cupola.** J. H. Eastham. *Iron Age*, Vol. 134, Oct. 18, 1934, pages 36-39. Due to increasing popularity of special alloys, suggests the installation of a small cupola in addition to battery of larger ones. A great factor in favor of a small cupola is the ability to cast a rush job at any time without interfering with the shop's regular schedule. An ideal jobbing foundry should consist of a battery of 3 cupolas with diam. (inside linings) of 48 in., 36 in. and a small one of 24 in. Gives actual experience on a rush job. VSP (6)

— **Notes on Cupola Practice.** F. Giolitti. *Metal Progress*, Vol. 27, Mar. 1935, pages 62,66. Discusses the lack of improvement in performance of the cupola as a melting tool compared to results achieved with rotary furnaces of arc or fuel fired types. WLC (6)

2 **Variety of Furnaces Required in Forming and Heat Treating Steel Springs.** J. B. Nealey. *Steel*, Vol. 95, Dec. 31, 1934, pages 16-18. Describes practice and equipment of the American Spiral Spring & Mfg. Co., Pittsburgh, Pa. Furnaces for heating for forming and heat treating are gas fired. MS (6)

— **Electric Melting of Aluminum (Die elektrische Schmelzen von Aluminium).** E. Fr. Russ. *Zeitschrift für Metallkunde*, Vol. 26, Dec. 1934, pages 285-287. A general discussion of the operating technique and the economic and technical advantages of electric resistance and induction furnaces, equipped with various types of crucibles and liners, for the melting of Al alloys and scrap. FNR (6)

3 **Electric Melting Furnaces for Aluminum and Aluminum Alloys (Elektrische Schmelzöfen für Aluminium und Aluminium-Legierungen).** C. Hanf. *Aluminium*, Vol. 17, Feb. 1935, pages 75-77. Describes a few box and tilting furnaces of 300-3000 kg. capacity. IIa (6)

— **Use of Electric Furnaces in Industrial Heat-treatment.** A. Glynne Lobley. *Metallurgia*, Vol. 11, Jan. 1935, pages 61-64, 86; Mar. 1935, pages 117-120. Points out advantages of electric furnaces and then describes typical furnaces used for different heat-treating operations. JLG (6)

4 **Evolution of Electric Melting Furnaces (L'évolution des fours électriques de fusion).** *Journal du Four Electrique*, Vol. 44, Feb. 1935, pages 59-62. General considerations. JDG (6)

5 **Critical Study of Electric Furnace Economizers (Etude critique des économiseurs de fours électriques).** *Journal du Four Electrique*, Vol. 44, Feb. 1935, pages 63-65. Mechanical features of the devices used to prevent the gas escape around electrodes in electric furnaces. JDG (6)

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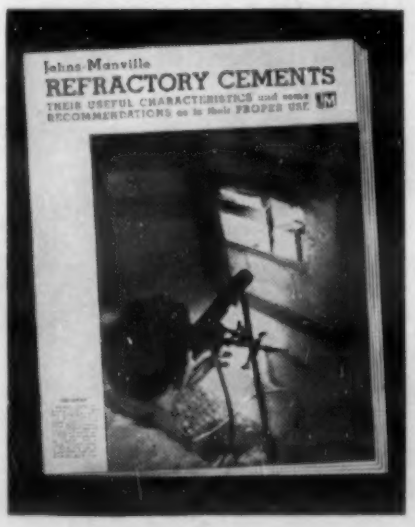

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Gas-operated car-type annealing furnace, insulated with 9" Armstrong's EF Brick and 9" Nonpareil Insulating Brick. Heat is kept uniform.

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ACCURATE temperature control is assured in this gas-operated car-type annealing furnace, built by Swindell-Dressler for a Pittsburgh manufacturer. Tests show a temperature variation of less than 10° in any part of the furnace, which operates from 1200° to 2000° F.

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The wide range of properties available is shown in the illustration above. The four all-weld metal Standard Tensile Test Specimens in the foreground, reading from left to right, tested as follows:

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Tensile Strength	64,500 p.s.i.	Reduction in Area	65.9%
Yield Point	53,500 p.s.i.	Elongation in 2 in.	37%

2. HIGH CARBON STEEL SPECIMEN

Tensile Strength	73,000 p.s.i.	Reduction in Area	63.5%
Yield Point	59,000 p.s.i.	Elongation in 2 in.	31%

3. 2½% NICKEL STEEL SPECIMEN

Tensile Strength	86,000 p.s.i.	Reduction in Area	64%
Yield Point	72,000 p.s.i.	Elongation in 2 in.	25.5%

4. CROMANSIL STEEL SPECIMEN

Tensile Strength	100,000 p.s.i.	Reduction in Area	55.5%
Yield Point	85,750 p.s.i.	Elongation in 2 in.	22.5%

The Murex line includes electrodes for high speed, down-hand welding of mild steel; for three position and horizontal fillet welding; for welding manganese, stainless, carbon-molybdenum, Cor-Ten, Mayari, Cromansil, copper-bearing, high carbon, and nickel steels; and for building up and hard surfacing plain carbon steels. All are standard Murex Electrodes that can be furnished promptly from stock . . . and, all possess the well known Murex ability to provide highest quality weld metal at lowest cost.

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7. JOINING

7a. Soldering & Brazing

C. H. CHATFIELD, SECTION EDITOR

Hard-soldering with the Blow Pipe. *Oxy-Acetylene Tips*, Vol. 14, Mar. 1935, pages 61-62. Silver soldering Cu vessels with the oxy-acetylene flame is described. Butts under 45° bevel are used. A mere film of solder is sufficient to make a joint of great strength. A saturated borax solution can be used as a flux which is brushed both on material and soldering wire. Ha (7a)

7b. Welding & Cutting

Arc Welding Chromium Steel and Iron. J. C. Hodge. *Metal Progress*, Vol. 27, Apr. 1935, pages 33-38. For protection of weld metal from oxidation coatings are used exclusively on this type of welding rod. English rod is of low carbon steel with coating containing the necessary alloy and slag forming constituents while American rod is of the alloy composition and the coating contains only the slag forming constituents. Deoxidizers such as Fe-Mn, Fe-Ti, or Al are a part of good coatings. Alloy wire is usually smaller than plain C wire and current density employed is lower. Direct current is used with work negative. For air hardening steels the work is preheated and maintained at preheat throughout the welding. Weld metal is usually made the same composition as the base metal. Loss of Cr in the weld with a properly compounded coating is stated to be 1.0-1.5%. Annealing of all air hardening steels is recommended and use of temperatures above the critical are best followed by controlled cooling at 50° F./hr. which will produce a uniform hardness from base metal on one side across the weld to base metal beyond. Cr-Fe alloys of 18% and over are not responsive to heat treatment and are subject to grain growth at elevated temperatures which makes welding inadvisable where impact or bending stresses occur on account of brittleness. At temperatures above 500° F. in service brittleness disappears and welding is satisfactory. Testing of completed welds by X-rays and use of companion welded test pieces subject to same heat treatment are discussed. WLC (7b)

Shrinkage Strains and Stresses Caused by Welding. R. Jensen. *Welding Engineer*, Vol. 20, Feb. 1935, pages 30-36; Mar. 1935, pages 21-23. The causes for the origin of strains and stresses in welds, their magnitude in different kinds of welds, and the influence of welding methods on the stresses are discussed and curves showing stresses as functions of temperature and theoretical reasons for it are given. 10 rules are developed to control and reduce stresses which are applicable to practically all methods of welding, gas or electric: the smallest amount of weld metal possible should be used; electrodes producing a greater amount of weld metal in unit time; pieces to be welded should be arranged so that they have, as much as possible, freedom to move in one or more directions; a piece being welded must not be left for a long period of cooling before being built-up fully; shrinkages may be decreased somewhat by using a partly fixed condition, e.g. by tack welding or weights; heat must be properly distributed over the seam; draft and wind must be excluded from the parts; bending of plate prevented; in general, end connections should be welded first and then seams. Methods for measuring stresses in welded plates are described. Ha (7b)

Oxy-Acetylene Welding Butt Welds Preferred (La Revanche de la Soudure Oxy-Acétylénique). R. Granjon. *Soudure et Oxy-Coupage (Supplement to Revue de la Soudure Autogène,)* Vol. 11, Oct.-Dec. 1934, page 233. Briefly explains that recent experience has proved that oxy-acetylene welding is preferable to arc welding in butt welding no matter what the thickness of the plates to be welded. FR (7b)

The Practical Side of Electric Resistance Welding. H. S. Jeffs. *Welding Journal*, Vol. 32, Jan. 1935, pages 6-7. A review of paper read at Institution of Welding Engineers, Jan. 9, 1935. Automatic spot and stitch welding described for mild steel. The heat line on either side of weld is about ¼" for material under 1/16" therefore less distortion results than in gas weld. Induction current regulator or modulator is used to prevent plucking of the copper electrode rolls which are water cooled. WB (7b)

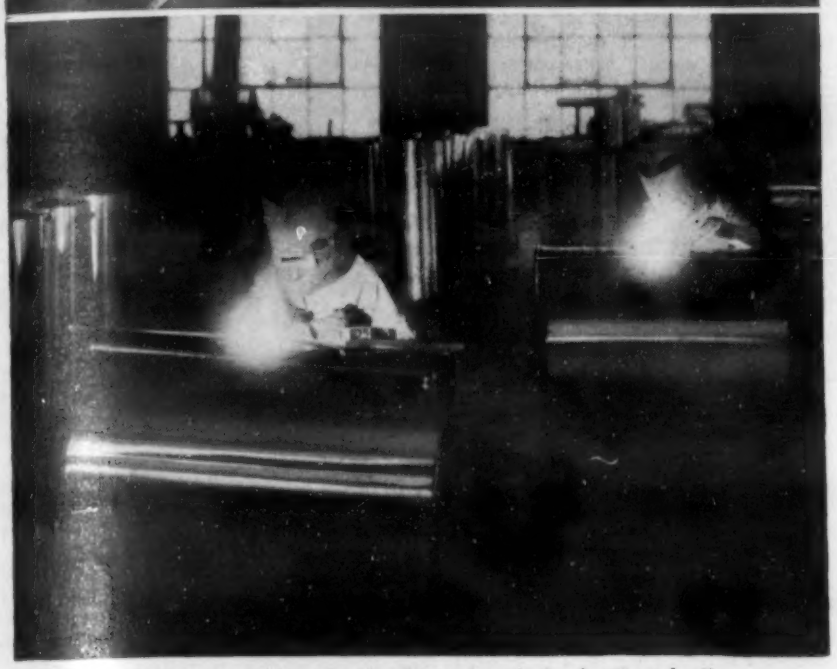
Resistance Welding. F. G. Rogers. *Electrical Review*, Vol. 116, Jan. 4, 1935, page 12. Outlines the various processes of resistance welding and points out some advantages. It is particularly suited to mass production. MS (7b)

Heavy Welding. R. G. Reid. *Welder*, Vol. 7, Jan. 1935, pages 435-438. Examples of very large welded pieces are described, such as a gear casing for a tube piercing mill, an electric furnace casing, and oil storage vessels. Ha (7b)

Lead Burning with the Oxy-Acetylene Flame (Bleischweissen mit der Azetylen-Sauerstoff-Flamme). F. Schulze & J. Staebler. *Autogene Metallbearbeitung*, Vol. 28, Mar. 1, 1935, pages 68-70. The advantages of the oxy-acetylene flame over the hydrogen flame usually employed for lead burning are pointed out. Especially for welding large masses the oxy-acetylene flame is more advantageous on account of its higher temperature which shortens the time of the process. Ha (7b)

Welding of Alloyed Steels (Schweissen legierter Stähle). K. L. Zeyen. *Autogene Metallbearbeitung*, Vol. 2, Feb. 1, 1935, pages 33-41. Welding methods and properties of the different types of alloyed steels suitable for welding are discussed at length; test results are given. Ha (7b)

Monel Metal WELDS vs *Carbon-Tetrachloride* CORROSION



Carbon-arc welding the Monel Metal tanks for the "Lustrlux" Dry Cleaning System, Butler Mfg. Co., Kansas City, Missouri.

Monel Metal dry-cleaning machines resist attack by the new chlorinated hydrocarbon solvents

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The polarity should be straight. Use small-diameter carbons (5/32, 3/16 or 1/4"), and to obtain better control of arc, taper them to pencil point for 2".

Keep the heat relatively low, and obtain a uniform, smooth flow with a short arc.

Use coated carbon-arc welding rod (INCO Carbon-Arc Monel Metal #20), and feed rod separately. Don't puddle.

This procedure avoids porosity, cracking... gives uniform penetration.

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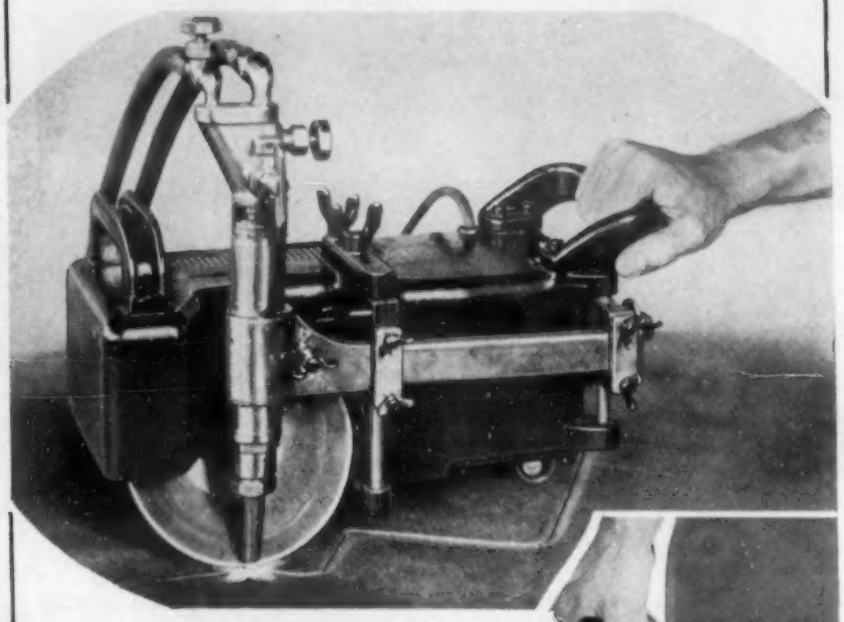

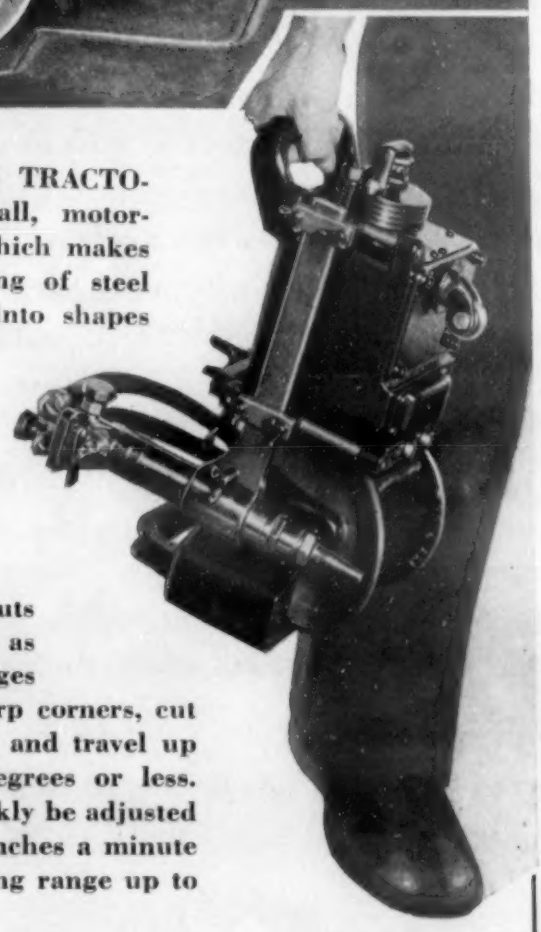

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When YOU Weld 18-8 Stainless Steels

with "Stainweld A" electrodes the welds will possess these properties . . .

Tensile Strength . . . 85,000 to 95,000 lbs. per sq. in. with yield point of 30,000 to 40,000 lbs. per sq. in.

Ductility . . . 50% to 60% elongation in two inches.

Impact Resistance . . . 100 to 120 ft. lbs. (Izod).

Density . . . as measured by specific gravity, 7.86 grams per c. c.

Corrosion Resistance . . . hundreds of tests prove weld resistance to corrosion equal to the plate.

Appearance . . . when ground smooth and polished it is practically impossible to distinguish the weld from the 18%Cr-8%Ni steel it joins. No pinholes or discoloration to reveal the weld or mar the polished surface.

Compare all the above values with the average properties of 18-8 steels.

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THE LINCOLN ELECTRIC COMPANY

Welding Research Division **Cleveland, Ohio**

W-135

Welding in Reinforced Chair Construction. Francis A. Westbrook. *Iron Age*, Vol. 134, Dec. 6, 1934, pages 20-22. Describes the spot welding of steel reinforced chairs used in restaurants, schools and other places as employed by the Allen Chair Co., New Concord, Mass. Steel parts are joined together by 72 spot welds and tests have shown them to possess great strength. Cost is less by welding than by other methods of construction. VSP (7b)

Progress in Bronze Welding (Les Progrès de la Soudo-Brasure). R. Granjon. *Revue de la Soudure Autogène*, Vol. 27, Jan. 1935, page 1. Summarizes recent improvements of method: special brasses which are used as added metal allow a good "wetting" and "gripping" on the surfaces. A shortcoming of the method, chiefly applied in repairing cast Fe castings, was the yellowish color of the joint; now Ni additions have provided the white color aimed at. FR (7b)

Effect of Welding Technique on the Construction of Boiler and Steam Vessels (Einfluss der Schweisstechnik auf den Bau von Dampfkesseln und Dampffässern). Czternasty. *Die Wärme*, Vol. 57, *Sonderheft*, Oct. 13, 1934, pages 680-686. Welding is considered the safest joining method in the construction of highly stressed pressure vessels. Due to the increased mass of structural materials, riveted members showed uneven heat distributions resulting in the development of cracks which are absent in welded constructions owing to a larger degree of elasticity and better cooling properties. The great significance of electric welding in built-up work in boiler plants is emphasized and the modifications of welding codes alongside advances in welding technique are historically reviewed. EF (7b)

Bronze Joints for Copper. *Oxy-Acetylene Tips*, Vol. 14, Mar. 1935, pages 53-55. Bronze welding was found useful for welding seams of thin-walled Cu or thin Cu sheets. Procedure is described. Ha (7b)

A Welded Highway Bridge. D. Anderson. *Welder*, Vol. 7, Feb. 1935, pages 464-467. Describes procedure on a 5 span bridge varying from 28 to 64 ft. width. Saving over riveting amounted to about 15%. Ha (7b)

Welded Steel Arch Rib Roof Frame Solved by Models. L. A. Beaufoy. *Welder*, Vol. 7, Feb. 1935, pages 477-479. The stresses occurring in the elements of the arch were ascertained on a model and results are used for applying correct welding methods and composition of parts. Ha (7b)

Welding Large Areas. A. C. Croskell. *Iron & Steel Industry*, Vol. 8, Dec. 1934, page 98. Photograph and description of a large universal, fully automatic flash butt welder designed to weld an area of 40 in.^{2} It can be used for various purposes such as the manufacture of heavy anchor links, welding large pipes to flanges, etc. CEJ (7b)

Metallographic Control of Welding Joints. V. A. Dun'kovich. *Zavodskaya Laboratoriya*, Vol. 3, Dec. 1934, pages 1101-1104. The results of micro- and macro-structural tests of welding seams with various proposed reagents are illustrated and discussed. Chas. Blanc (7b)

Spot Welding. Lawrence Ferguson. *Journal American Welding Society*, Vol. 14, Mar. 1935, page 18. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 106. WB (7b)

Various Types of Electrodes, Their Different Metallurgical Properties, and the Resulting Variations in the Welded Material (Olika slag av elektroder, deras skillnad i metallurgiskt hänseende samt därutav betingade skillnader hos svetsmaterialet). Elis Helin. *Teknisk Tidskrift*, Vol. 65, Mar. 9, 1935, pages 75-83. Discusses the chemical composition of various types of welding electrodes and the chemical reactions which may take place during welding. Describes the physical tests used for the welds, the effect of the current density on the quality of the welds, and the best methods of heat treatment. BHS (7b)

Studies of the Metallurgy of Arc Deposited Weld Metal. Samuel L. Hoyt. *Transactions American Society for Metals*, Vol. 23, Mar. 1935, pages 61-93. Paper read and discussed at A.S.M. Convention 1934. Previously abstracted from Preprint 20, 1934. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 571. WLC (7b)

Use Care in Selecting Your Welding Cable. A. Madson. *Welding Engineer*, Vol. 20, Mar. 1935, pages 24-25. Performance of arc-welder and quality and economy of work done can be favorably influenced by careful and correct selection of the cable connecting welding machine and work. Ha (7b)

Recent Developments in Welding as Applied to the Foundry Industry. R. Tyler & L. C. Percival. *Foundry Trade Journal*, Vol. 52, Jan. 3, 1935, pages 18, 20; Jan. 10, 1935, pages 41-43. Welding can be divided into 2 distinct and separate categories—forge welding and fusion welding. Forge welding has no application in the foundry for production or amelioration of casting but fusion welding, in the opinion of the authors, can be of the greatest service to the foundry. Amongst the many applications of welding applied to steel castings, the following are most often met with:—Building up castings which will not "clean up" owing to insufficient allowance for machining, building up surfaces to remedy excentricity, etc. Current oxy-acetylene welding practice allows the deposition of metal on mild steel castings identical with the material of the casting. A bronze welding process can be applied to the welding of cast iron and malleable iron castings without preheating to any great extent. In all ordinary circumstances, according to the authors, galvanic action due to dissimilarity between weld metal and parent metal is not apparent. A recently-developed process claims to have combined all the advantages of the cast-iron fusion-welding process and of the bronze-welding process, and to have eliminated all the disadvantages of bronze welding and practically all the disadvantages of the cast-iron fusion welding process. The application of welding to non-ferrous castings is also discussed. AIK (7b)

Welding by the Metallic Electrode Process. H. Thomasson. *Canadian Machinery & Manufacturing News*, Vol. 46, Jan. 1935, page 26, Section 80 *Canadian Welder*. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 106. WB (7b)

The Development of Electric Welding on Warship Work. R. Stewart. *Welder*, Vol. 7, Feb. 1935, pages 453-454. Processes of welding in warship construction, especially of galvanized parts are described by the example of 2 British warships. Ha (7b)

8. FINISHING

H. S. RAWDON, SECTION EDITOR

8a. Pickling

Alkaline Anodic Pickling of High-Speed Steel. RAYMOND R. ROGERS. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 357-360. High speed steel is anodically treated at 2.7 amp./dm.² in an alkaline bath containing 115 g./l. NaOH plus 15 g./l. citric acid. When the gas evolution is entirely uniform, the pickling has been completed. Specimens are then washed and momentarily dipped into HCl solution. The alkaline anodic treatment causes tungsten to go into solution with comparative ease, whereas in the older HCl dip, the interaction with tungsten compounds was unsatisfactory. (8a)

New Process Converts Waste Ferrous Sulphate to Sulphuric Acid. S. F. SPANGLER. *Chemical & Metallurgical Engineering*, Vol. 42, Mar. 1935, pages 139-141. The manufacture of H_2SO_4 from waste $FeSO_4$ solution involves (1) neutralization and evaporation of sulphate solution in rotary dehydrator (2) decomposition of anhydrous $FeSO_4$ into SO_2 in rotary roaster (3) conversion of SO_2 to H_2SO_4 by use of vanadium catalyst in standard Chemico contact acid plant. A large plant has been put in operation and another is being built to recover acid from manufacture of titanium dioxide analyzing 18-25% H_2SO_4, 10-16% $FeSO_4$, traces $TiSO_4$. The advantage of the process to steel mill management is elimination of the nuisance in getting rid of spent pickle solution, and recovery of acid without fumes, waste or other nuisances. PRK (8a)

Developments in Electrolytic Pickling. A. E. CHESTER & C. J. KRISTER. *Metal Cleaning & Finishing*, Vol. 7, Jan. 1935, pages 30-33. Describes several processes most of which depend on the use of H_2SO_4 and d.c. One method uses a.c. Short bibliography is given. GBH (8a)

8b. Cleaning, including Sand Blasting

New Type Solvent Machines Used to Clean Metal Parts. G. E. POWERS. *Iron Age*, Vol. 135, Jan. 17, 1935, pages 31, 80. Describes cleaning metal parts with chlorinated solvent in solvent machines which is being adopted in all lines of metal industry. Metal may be cleaned by solvent vapors, by spraying of solvent or by a combination of two or more of these methods. VSP (8b)

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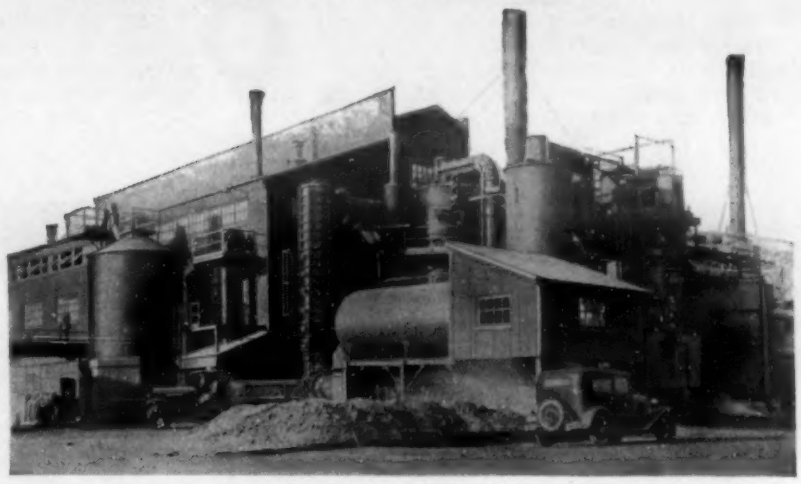

THE first large commercial plant (shown above) for making sulphuric acid direct from waste iron sulphate solution is now in steady operation, and is so successful that its owner has a second plant of the same capacity under construction.

Plants of this type are particularly desirable for treating spent liquors from pickling tanks in the steel industry. Through utilization of the sulphur content from these otherwise worthless liquors, and conversion into clear sulphuric acid of any desired strength,—this new Chemico process makes acid recovery highly desirable and in addition converts the iron sulphate into iron oxide. By making the plant slightly larger, fresh acid may also be produced in sufficient quantity for make-up.

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The Effect of Composition and Pre-treatment of Steels upon the Life of Protective Coatings. KARL DAEVES. *Transactions Electrochemical Society*, Vol. 64, pages 99-112. See "Clean Surfaces Essential in Protective Coating of Steel," *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 406. (8b)

Sandblasting. KENNETH HILL. *Foundry Trade Journal*, Vol. 52, Jan. 17, 1935, pages 55-56. The paper was read at a meeting of the Institute of Vitreous Enamelers, London. Systems generally used, sand blast chambers, rotary tables, centrifugal sand blast plant, etc. are discussed. AIK (8b)

Cleaning of Tinned Surfaces. E. KLIKA. *Metal Cleaning & Finishing*, Vol. 7, Feb. 1935, page 76. Tarnished hot-tinned surfaces may be cleaned either by immersing (A) in palm oil heated to 300° F. or (B) in a 2% solution of HNO_3, followed by rinsing in kerosene. GBH (8b)

Recent Advances in Metal Cleaning Technology. Part 1. R. W. MITCHELL. *Metal Cleaning & Finishing*, Vol. 7, Jan. 1935, pages 9-14; Feb. 1935, pages 65-68. Properties of many of the new degreasing solvents are described and methods of degreasing explained. Second part is a general discourse on wetting agents and sulphonated cleaners. GBH (8b)

8c. Polishing & Grinding

Finishing Truck Cylinder Liners. W. PAUL EDDY JR. *Abrasive Industry*, Vol. 16, Feb. 1935, pages 11-13. Procedure in finishing liners is taken up from the previous article which described the hardening operation. The liners are ground to insure perfect roundness. WB (8c)

Accurate Dies Assured by Grinding. FRED B. JACOBS. *Abrasive Industry*, Vol. 16, Mar. 1935, pages 12-15. Multisectional dies are ground to close tolerances for forming pressed sheet steel shapes. In case of die injury the injured section can be easily and quickly replaced with a spare. Special wheel shapes are used to obtain the desired contour. WB (8c)

Modern Polishing on a Production Basis. FRED B. JACOBS. *Iron Age*, Vol. 134, Dec. 6, 1934, pages 16-19. Describes method used at the plant of the White Sewing Machine Co., Cleveland. Approximately 2,500,000 separate sewing machine parts are polished annually on the 18 polishing and buffing lathes used. VSP (8c)

How Attractive Finish Helps Metal Products Sales—25. Design as a Factor in Economical Polishing and Buffing. ROBERT T. KENT. *Iron Age*, Vol. 134, Sept. 20, 1934, pages 16-19. Describes methods for reducing finishing costs by changing the basic design of metal product. Gives some typical examples. VSP (8c)

Mechanical Lapping. S. PLAYER. *Automobile Engineer*, Vol. 25, Feb. 1935, pages 55-56. Lapping as finishing process for parts requiring high accuracy, e.g. Diesel fuel pump and injector parts, should be carried out in 3 stages: rough mechanical lapping, an enveloping cylindrical lap, and finish mechanical lapping. Equipment and procedure for the 3 stages are described and economical considerations discussed. Ha (8c)

8d. Electroplating

Electrodeposition of Aluminum from Non-Aqueous Solutions. R. D. BLUE & F. C. MATHERS. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 339-355. Al of high purity can be deposited easily in a bright, finely crystalline, adherent form from a solution made by dissolving metallic Al in ethyl bromide and benzene (C_6H_6) Al bromide being used as a starter or catalyst. Toluene, xylene, β-tetra-hydro-napthalene, and kerosene may be substituted for benzene under certain conditions and ethyl chloride, methyl chloride, and ethylene dichloride for ethyl bromide. The Al adheres well to Pt, Cu, steel and cast iron but not to Mg or Al. The bath has a current efficiency of 60% and over at both electrodes and a throwing power as high as 28. The bath does not deteriorate and can be operated indefinitely if moisture is excluded. A definite decomposition voltage does not exist. The potential drop varies directly and regularly with the current. (8d)

Nickel Plating Zinc. ALBERT HIRSCH. *Metal Industry*, London, Vol. 45, Aug. 31, 1934, page 208. Advantages of Zn for fabrication over other metals are pointed out. Among these are: (1) Zn is softer and more easily worked; (2) dies are longer lived; (3) on basis of relative weights of brass and Zn and prices of the two, Zn will go further at approx. ⅓ the cost of brass per pound. Other advantages are the fact that Ni-plated Zn can replace steel where corrosion is a factor, and that Zn will not rust-stain as steel does nor color washable material as brass does. The author's methods of preparation of Zn surfaces, solutions used, and conditions required for Ni plating are given. HBG (8d)

The Mechanism of Electrodeposition. L. B. HUNT. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 413-427. The mechanism of electrodeposition is discussed from the point of view of the supply of metal ions and their distribution at the cathode-electrolyte interface, the supply of electrons from the cathode, and the factors determining the electron transitions and subsequent lattice development. Volmar's concept is criticized and an alternative hypothesis advanced to account for lattice development and the observed polarization phenomena. An accumulation of metal ions by adsorption in the double layer until a continuous lattice layer can be formed therefrom over the face of any particular crystal is suggested. The movement of electrons through the cathode surface is dependent upon the presence of adsorbed ions in a condition permitting their acceptance of electrons. (8d)

Brass Plating as Intermediary Layer (Messingüberzüge als Zwischenschichten). A. BRAUN. *Oberflächentechnik*, Vol. 12, Feb. 19, 1935, pages 39-42. Great advantages are claimed for an intermediary layer of brass instead of Cu under Ni or Cr plating. A good brass layer can be obtained in fairly short time, 30-40 min., by addition of some ammonia, As and especially phenol as bright-plating agents to the bath and the deposit maintains its original brightness. Since the brass bath is alkaline this offers a particular advantage as many baser metals cannot be Cu plated in an acid bath and Cu deposition from an alkaline bath is not very good. Brass protects Fe from rust better than Cu as the deposit is denser. The brass bath has the following composition: 40 g. Cu-K cyanide, 40 g. Zn-K cyanide, 15 g. anhydrous soda, 15 g. Na_2SO_4, 10 g. NH_4Cl, for 1 l. H_2O. The average current density at room temperature is 0.3-0.4 amp./dm.^{2} and this can be increased to more than 0.6 for higher temperatures. The throwing power of a brass bath on Fe is somewhat better than the Cu bath and the adherence is just as good. On light metals the brass deposit has a decided superiority over Cu with respect to adhesion, and Cr and Ni adhere better on brass than on Cu. Zn does not require a special treatment as do the light metals before brass-plating; ordinary degreasing suffices. On Sn brass plating is of advantage, especially on Sn die-castings. The current efficiency is better than for Cu especially at higher current densities. The best procedures for brass plating on Fe, Al, Zn and Sn are described in detail. 17 references. Ha (8d)

Protective Value of Nickel and Chromium Plating on Steel. WILLIAM BLUM, PAUL W. C. STRAUSSER & ABNER BRENNER. *Journal of Research National Bureau of Standards*, Vol. 41, Sept. 1934, pages 331-335. Exposure tests on plated steel, in coöperation with the American Electroplaters' Society and the American Society for Testing Materials, were conducted in rural, suburban, industrial, and marine locations. It was found that the thickness of the Ni layer is the most important factor. An intermediate layer of Cu decreases the protective value of thin coatings but is not detrimental in thicker ones, especially if they are Cr plated. The customary thin Cr coatings (0.00002 in. or 0.0005 mm.) increase the resistance to tarnish, but not the protection against corrosion. The use of Zn under Ni makes the protective value less than that of either metal alone. Cd has very little effect under Ni. Zn or Cd under Ni tends to produce white stains and blisters. The conditions of Ni deposition and the preliminary cleaning and pickling have no marked effects on the protective value. WAT (8d)

Chromium Plating Literature. XXXI, XXXII. L. H. DECKE. *Platers Guide*, Vol. 31, Jan. 1935, pages 14-15; Feb. 1935, pages 14-16. These instalments deal with Ni sub-coats. WHB (8d)

The Gilding of Aluminium. W. FRÖHLICH. *Sheet Metal Industries*, Vol. 8, Oct. 1934, pages 594-595. See "Gold Plating of Aluminum," *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 62. AWM (8d)

Some Further Electrochemical Principles Applied in Electrodeposition. No. 1—Secondary Electrodes. SAMUEL FIELD. *Electrometallurgy*, supplement to *Metal Industry*, London, Vol. 45, July 20, 1934, pages 61-63; Aug. 31, 1934, pages 205-206. After outlining the operation of an electrolytic cell and the use of porous non-conducting partitions, the author shows how conducting partitions or diaphragms are utilized in the electrolytic production of pure Cu. If Pb sheets, rather than crude Cu form the so-called "secondary electrodes," Cu may be deposited but the formation of H_2SO_4 changes the electrolyte considerably. By varying the dimensions of the Pb "secondary electrodes" some interesting data were secured. HBG (8d)

Deposits Low in Hydrogen (Wasserstoffarme Niederschläge). W. ECKHARDT. *Oberflächentechnik*, Vol. 12, Feb. 19, 1935, page 43. Experiments to find a bath composition for Ni plating which reduces the harmful effects of H absorption by the basis metal led to the following bath: Ni sulphate 80 g., Ni fluoride 8 g., NaCl 1 g., Na_2SO_4 0.5 g., $NaNO_3$ 0.02 g., sulpho-sodium phenolate 0.12 g., Na citrate 2 g., boric acid 6 g., zircon-ammonium fluoride 0.2 g., all in 1 l. H_2O. The ammonium fluoride binds H and the deposits adhere well to the base. Voltage is 2 volts. Ha (8d)

Studies on Overvoltage. VI. The Mechanism of the Transfer of Electrolytic Hydrogen and Oxygen Through Thin Sheets of Platinum and Palladium. A. L. FERGUSON & GEORGE DUBPERNELL. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 221-247. The nature of the diffusion of anode and cathode polarization products through thin sheets of Pt and Pd has been investigated and it was found that no diffusion of electromotively active material occurs through solid metal, even though very thin. When a change in the potential of the back of a thin electrode occurs, the metal is not perfectly continuous and a small solution connection is established in the discontinuities through which a small amount of current flows and charges the back. A critical review of previous work in this field shows that the results of earlier workers confirm the present findings. Inconsistencies in the previous work are satisfactorily explained. A general theory is developed to explain the results obtained in a number of different fields of investigation, and a satisfactory theory of the blistering of metals proposed. The value of the present research in clarifying the theory of polarization and overvoltage is discussed. (8d)

The Electrodeposition of Copper, Nickel and Zinc Alloys From Cyanide Solutions. Part I. CHARLES L. FAUST & G. H. MONTILLON. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 361-375. The experimental results indicate that alloys of Cu, Ni and Zn can be deposited from cyanide solutions. All of the deposits were bright, uniform, smooth, and adherent and the color varied from golden Cu to Pt white. Deposition favored Zn and Cu over Ni. Data were obtained to determine the conditions of temperature, bath composition, and current density which would give deposits having the color characteristic of "nickel-silver" alloys. (8d)

The Electrodeposition of Indium From Cyanide Solutions. DANIEL GRAY. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 377-383. Aqueous solutions of indium cyanide dissolved in an excess of cyanide are unstable as there is a marked tendency for $In(OH)_3$ to form. This precipitation may, however, be prevented and the bath rendered very stable by adding a very weak acid, such as glucose or glycine (½ g. glucose per g. In-content of bath). Soft silver-white deposits of In are obtained from this bath of 30 to 60 g./l. In, at current densities of 1 to 16 amp./dm.^{2}, and room temperature. (8d)

Action of Germanium in the Electrolysis of Zinc Sulphate Solutions (L'azione del germanio nella elettrolisi di soluzioni di solfato di zinco). PIETRO GUARESCHI. *Industria chimica*, Vol. 9, Nov. 1934, pages 1466-1476. As little as 1/10,000,000 parts of Ge reduces the efficiency of Zn electrolysis greatly, at low current densities (600-700 amps./m.²). Higher current density reduces interference by increasing H_2 overvoltage, e.g., at 3000 amps./m.², 0.0005 g./l. of Ge does not interfere. With 0.0016 g./l. of Ge, it is not possible to electrolyse $ZnSO_4$ even at 4000 amps./m.² Certain organic compounds, such as $CaCN_2$, sugar, pyridine, triethanolamine reduce the interference somewhat, though not so well as they neutralize Co or Ni. AWC (8d)

Investigation of the Process of Mutual Displacement of Metals. N. A. ISGARISHEW & I. A. MIRKIN. *Zhurnal Obshey Khimii (Journal of General Chemistry)*, Vol. 4, (66), No. 7, 1934, pages 982-987. In Russian. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 572. NA (8d)

Galvanoplastics (Galvanostegia). V. P. SACCHI. *Industria Meccanica*, Vol. 16, Oct. 1934, pages 808-811; Nov. 1934, pages 885-888. Methods of metal deposition, chemical composition of electrolytes, influence of variations of composition and general practice are reviewed. Ha (8d)

Recent Developments in the Electrodeposition of Nickel. A. W. HOTHERSALL. *Electrometallurgy*, supplement to *Metal Industry*, London, Vol. 45, Aug. 3, 1934, pages 109-112; Aug. 17, 1934, pages 157-159. This article, also published in a booklet by the Mond Nickel Co., Ltd., is a discussion of the more important advances made in the electrodeposition of Ni during the past few years. 39 references. HBG (8d)

Plating Parts at Packard. W. H. GRAVES & J. W. HIGGINS. *Iron Age*, Vol. 134, Nov. 15, 1934, pages 24-30. Description of the new plating department of Packard Motor Co. and layout of the plant with methods of procedure. The department consists of 9 separate units—Polishing; automatic Cu and Ni plating; Cr plating; barrel plating; buffing; burnishing; and inspection. Includes a typical process specification for plating work. VSP (8d)

New Developments in the Field of Electro-plated Coatings (Neuere Erfahrungen auf dem Gebiete der galvanischen Überzüge). A. POLLACK. *Chemiker-Zeitung*, Vol. 58, Dec. 12, 1934, pages 997-1001. Brief review of recent developments in the use of inhibitors for pickling, H_3PO_4 for pickling, electrolytic pickling, electrolytic roughening, cleaning in alkali with and without current; fast Ni plating; Ag, Sn, Pb, Cr, black Cr, and Cd plating; plating of large pieces; automatic plating equipments; deposition of alloys, Cd-Zn, Zn-Hg, Ag-Ni and Au-Ni; plating on Al alloys and die castings; and Rh and W plating. 27 references CEM (8d)

Reports of the Aeronautical Commission for the Study of Corrosion. A New Method for Producing Metallic Deposits on the Surface of Aluminum or Aluminum Alloys (Mémoirs des travaux de la commission aéronautique pour l'étude de la corrosion. Sur un nouveau procédé d'obtention de dépôts métalliques à la surface des objets en aluminium ou alliages d'aluminium). CHARLES BOULANGER. *Revue de Métallurgie*, Vol. 32, Oct. 1934, pages 440-441. Aluminum and its alloys can be coated with any one of a number of metals from the corresponding cyanide solution by simple immersion. Some formulas for deposition of Cd, Cd+Co and Co+Cr are given. Time, temperature and composition should be closely controlled. Deposits are thin but adherent. JDG (8d)

Electrodeposition of Lead From Dithionate Baths. R. L. BATEMAN & F. C. MATHERS. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 283-291. Excellent cathode deposits of Pb can be obtained easily from a solution containing 4% of Pb dithionate and 2% of free dithionic acid, together with glue and β-napthol, as addition agents, in quantities of 0.005% or more each. In general, hydroxyaromatic compounds such as β-napthol, cresol, etc., used with glue, are good addition agents. (8d)

Nickel Anodes (Gli anodi di nickel). A. BARATTINI. *Industria Meccanica*, Vol. 17, Jan. 1935, pages 9-12; Feb. 1935, pages 107-108. The points of view which should determine the selection of Ni anodes are discussed. Cast anodes even if sufficiently pure have a low efficiency because they disintegrate irregularly on account of their porosity and leave a high percentage of non-utilizable residue. They may be used in baths with high densities but give an extremely low efficiency. Bright, rolled anodes are not very suitable as they remain passive for a long time and dissolve slowly. They disintegrate irregularly and result in considerable waste on brushing. They should be used only in baths with light operation. Soft, rolled anodes, i.e., anodes heat treated and mechanically treated so that they have a soft, rough surface are attacked by the electrolyte regularly and uniformly and give much higher efficiency. They are suitable for dense baths with medium intensity. Electrolytic anodes show still greater passivity or lower efficiency than the cast or rolled anodes according to whether the bath is poor or rich in chlorine. Depolarized anodes give better efficiencies in all cases. They are particularly indispensable in baths of high and medium densities. A table shows the behavior and losses of the different types of anodes under different operating conditions. Ha (8d)

Plating Plant Layout. A. J. LUPIEN. *Metal Industry*, N. Y., Vol. 33, Mar 1935, pages 95-97. From the *Monthly Review*, Jan. 1935. Read before American Electroplaters Society, Detroit, 1934. The technique of plant layout consists in drawing to scale a diagram of the proposed space. Attention should be paid to (1) economy of space (2) smooth flow of work (3) efficiency of processing (4) conservation of electrical energy and materials (5) appearance. There are instances when time study diagrams will readily show how a layout can be replanned to increase production. In such diagrams choke points are readily revealed. PRK (8d)

The Rate of Displacement of Copper from Solutions of Its Sulfate by Cadmium and Zinc. CECIL V. KING & MARTIN M. BURGER. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 403-411. The rate of displacement of Cu from dilute $CuSO_4$ solution by Cd and Zn has been measured and compared with previous experiments and with the rate of solution of Zn in acids. The rate is controlled, up to peripheral speeds of the metal surface of at least 44,000 cm./min., by diffusion and electrolytic transport of the Cu^{++} ion to the surface of the more active metal and the Cu already deposited. There is no indication that the chemical reaction rate is slow enough to be a controlling factor at any stirring speed studied. (8d)

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Ductility and Adhesion of Nickel Deposits. F. P. Romanoff. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 385-401. The ductility of electrodeposited Ni is a function of the crystal structure and of the contained basic salts and gases. Hard fibrous or columnar Ni coatings apparently have a hardening effect on a ductile base even when very thin. This effect disappears however, upon removing the deposit. Full ductile conical Ni structures of any thickness do not affect the base adversely. Ductile Ni can be hardened by absorption of H through action as a cathode in alkaline or acid solutions. Cr deposition on Ni has the same effect. Part of this hardening can be overcome through vacuum or heat treatment, or by Cr plating under conditions which prevent the absorption of much H. Testing for adhesion by the Erichsen extruded cup test, or modifications thereof, is shown to be unreliable. A modified cup test is given which will always detect poor adhesion. (8d)

Chromium Plating from Ammonium-Chromate-Sulfate Baths. Raymond R. Rogers & John F. Conlon. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 299-304. Baths containing combinations of ammonium chromate, $(NH_4)_2SO_4$, NH_4OH, chromic acid and H_2SO_4 were investigated to determine the range of compositions from which Cr metal may be electrodeposited. This range is plotted upon a ternary diagram with NH_4, CrO_4 and SO_4 as the variables. (8d)

Electrodeposition Progress in 1934. S. Wernick. *Industrial Chemist*, Vol. 11, Jan. 1935, pages 30-32. A résumé of work published during the year. 17 references. RAW (8d)

Recent Developments in Electroplating. S. Wernick. *Journal Society of Chemical Industry*, Vol. 53, Nov. 9, 1934, pages 948-953. Review of developments particularly in the deposition of Ni, Cr, Cd and the precious elements. VVK (8d)

Electrolytic Deposits of Nickel-Iron Alloys (Galvanische Niederschläge von Nickel-Eisen-Legierungen). E. Raub & E. Walter. *Zeitschrift für Elektrochemie*, Vol. 41, Mar. 1935, pages 169-174. Tests with organic acid additions to $NiSO_4$ plating baths were made in an attempt to check the harmful effect of Fe in the bath. This plates out with the Ni and results in a brittle deposit. It was intended that the Fe should form complex ions with the acids used, tartaric, citric and lactic and thus be prevented from depositing. This reaction occurred at a pH of about 3-4 but, at pH of 4-6, a complex colloidal formation was the rule, consequently the deposits obtained in the higher range of pH were again brittle. Citric and tartaric acids were the most effective in promoting dense, adherent ductile deposits. Lactic acid invariably gave spongy, powdery deposits. Plates of Ni-Fe were made with a different bath but were not corrosion-resistant because of high porosity. The formation of pits in the Ni-Fe deposit was prevented by the addition of a German product, "Nekal" a salt of alkylnapthalinsulfo acid, to the plating bath. Adherent deposits were obtained only with bath temperature of 70°-80° C. WB (8d)

Practical Plating. The Deposit of Copper : Copper Cyanide. E. A. Ollard & J. W. Perring. *Electrometallurgy*, supplement to *Metal Industry*, London, Vol. 45, Sept. 21, 1934, pages 277-279. The Cu cyanide bath, sometimes called the alkaline Cu bath, is generally used for plating ferrous metals and Zn-base alloys. Due to the careful adjustment and control required, its chief use is for thin plating. Its advantages and disadvantages are indicated and the theory of this type of bath is discussed. It consists of the double cyanide of Na or K with Cu in the cuprous state. Opinions differ as to whether Na or K should be used. The reason for the excess of cyanide and method of preparation are indicated and a list of other substances, sometimes added, is given. A method is suggested for controlling the cyanide content by the "look of the solution and the way it works." HBG (8d)

A New Bath for the Direct Nickeling of Zinc. George W Nichols. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 265-270. Includes discussion. See *Metals & Alloys*, Vol. 5, May 1934, page MA 206. (8d)

Electrodeposition of Iron-Copper-Nickel Alloys. Part III: Deposition from Sulfate-boro-citrate Baths. Lawrence E. Stout & Charles L. Faust. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 271-282. Ternary alloys of Cu, Ni and Fe may be deposited from alkaline sulphate solutions containing ammonium boro-citrate. The boro-citrate overcomes the difficulty caused by the chemical reduction of the Cu content of the solutions. The current density range for good deposits is from 0.5 to 2.0 amp./dm.^{2} (8d)

Throwing Power and Current Efficiency of the Nickel Plating Solution at Low and at High pH. Russel Harr. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 249-264. High-pH solutions have better throwing power than low-pH solutions under all conditions of temperature and current density. Throwing power of all solutions is improved by raising the temperature this being very marked with low-pH solutions, which have very poor throwing power at room temperature. The throwing power of low-pH solutions increases with increase of current density, whereas that of high-pH solutions decreases. Increasing the concentration of $NiSO_4$ from 300 g./l. (40.1 oz./gal.) to 450 g./l. (60.2 oz./gal.) causes a small decrease of throwing power for high-pH solutions and a small increase of throwing power for low-pH solutions. Hydrogen peroxide has very little effect on throwing power in solutions of high pH due to its rapid decomposition. In low-pH solutions it may reduce throwing power very seriously by the formation of soluble Fe^{+++} salts. Fe^{++} has no effect on throwing power. Fe^{+++} (soluble only in low-pH solutions) is most effective in reducing throwing power. Best reproducibility of results in the determination of throwing power is obtainable by the use of small wire cathodes. (8d)

The Electrodeposition of Bismuth from Perchloric Acid Solutions. M. Harbaugh & F. C. Mathers. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 293-298. Bi perchlorate does not hydrolyze and precipitate even when diluted with much water. All other Bi salts do. Smooth cathode deposits can be obtained from Bi perchlorate solutions at room temperature with a current density of 3.1 amp./dm.^{2} (28 amp./ft.^{2}). The deposits are smooth, finely crystalline, and quite free from rough edges. Apparently, addition agents are really not needed; still, suitable addition agents such as glue and cresol improve the deposits somewhat. Analysis of the deposited Bi showed the presence of appreciable quantities of perchlorate; hence, the complex Bi salt may have acted as its own addition agent. (8d)

Chromium Plating Literature. XXXII-XXXIII. L. H. Decke. *Platers' Guide*, Vol. 31, Feb. 1935, pages 14-16; Mar. 1935, pages 14-16. These installments dealing with Ni-sub-coats close the series on chromium plating. WHB (8d)

Methods of Suspension in Electrodeposition Practice. C. F. J. Francis-Carter & B. J. R. Evans. *Paper* read before *Electrodepositors' Technical Society*, Jan. 16, 1935, pages 41-56. General remarks on wiring and racking of articles to be plated. GBH (8d)

A Cyanide-free Bath for the Deposition of Copper on Steel. Colin G. Fink & Chaak Y. Wong. *Transactions Electrochemical Society*, Vol. 63, 1933, pages 65-73. Includes discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 271. (8d)

A Study of the Tellurium Electrode. Frederick H. Getman. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 201-208. The normal potential of the Te electrode, Te, Te^{++++} was determined employing single crystals of tellurium as electrodes. The method of casting single crystals of tellurium, the general crystallographic characteristics of the crystals, and the manner of mounting the crystals for use as electrodes are described. The values of the e.m.f. of the cell Te, $TeCl_4$(m)2.5*N* HCl-KCl(sat'd)-Hg_2Cl_2-Hg at 25° C., for concentrations ranging from 0.0004 to 0.01 molar were measured. From the results the normal electrode potential was calculated and found to be Te, Te^{++++}, $E_0 = -0.5682$ volt. (8d)

The Electrodeposition of Magnesium. D M. Overcash & F. C. Mathers. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 305-311; *Metal Industry*, London, Vol. 43, Nov. 10, 1933, pages 473-474. Mg could not be electrodeposited from solutions of simple Mg salts in non-aqueous solutions, but was successfully electrodeposited from solutions of complex Mg compounds similar to Grignard compounds dissolved in various non-aqueous solvents, the best non-aqueous liquid being dimethylaniline. Anodes of Mg would not dissolve, but deposits of Mg could be obtained easily on the cathodes. Ha (8d)

The Adhesion of Electrodeposited Coatings to Steel. A. W. Hothersall. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 69-85. Includes discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 272. (8d)

8e. Metallic Coatings other than Electroplating

Determination of the Thickness of the Zinc Layer on Galvanized Wires and Sheets (Zinkstärken auf verzinkten Drähten und Blechen und deren Bestimmung). H. Meyer auf der Heyde. *Oberflächentechnik*, Vol. 12, Mar. 5, 1935, pages 58-59. Some practical methods to determine the thickness of Zn coatings by weighing before and after dissolving the Zn, or from dimensions of the bare wire or sheet, are explained together with tables showing the differences in dimensions and weights for different thicknesses. Ha (8e)

Metal Spraying Process in Electrical Manufacturing. John A. Campbell. *Metallizer*, Vol. 3, Dec. 30, 1934, pages 5-7, 9. Reprinted from Nov. 1934 issue of *Electrical Manufacturing*. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 109. BWG (8e)

The Development & Control of Spangles on Galvanized Iron. Part 1. W. G. Imhoff. *Metal Cleaning & Finishing*, Vol. 7, Feb. 1935, pages 69-72. Mentions over 80 variables that may influence the character of spangles. GBH (8e)

Aluminum Improves Finish in Galvanizing. W. G. Imhoff. *Metal Cleaning & Finishing*, Vol. 6, Oct. 1934, pages 509-512. Addition of Al imparts a bright bluish luster to non-spangled coatings. The effects of Al on operation and maintenance of the bath are given. GBH (8e)

Metallic Cementation by Means of Aluminium Powder. Tsutomu Kase. *Kinzoku no Kenkyu*, Vol. 12, Jan. 1935, pages 49-66. In Japanese. By means of commercial Al powder, the cementation of Al into Fe, Cu and Ni at various temperatures between 600°-1200° C. was investigated. The hardness and the depth of penetration of the surface layer of the cemented specimens were measured, microscopic and chemical analyses were carried out, and the oxidation at high temperatures and the resistance to corrosion by some acids were studied. Al diffuses into the metals mentioned at a temperature above 650° C. or the melting point of Al, and the rate of diffusion increases as the temperature rises. The rate of diffusion into Fe, however, increases abruptly at the A_3 point (906° C.). The relation between the weight increase of the specimen (ΔW), or the depth of penetration (P), and the absolute temperature of cementation (T) can be expressed by an exponential function, ΔW (or P) $= ae^{-b/T}$; the relation between the ΔW, or P, and the cementation. (Θ) by the similar function ΔW (or P) $= ae^{b\Theta}$, where a and b are different constants in each case. The cemented surfaces resist atmospheric oxidation and the attack of fused salts at high temperatures. Surfaces of Fe and Ni cemented by Al are not easily attacked by concentrated HNO_3. KT (8e)

Keeping Your Lathe Busy. L. E. Kunkler. *Metallizer*, Vol. 3, Dec. 31, 1934, pages 8, 14. Advantages of combining custom metal spraying with small machine shop operation are discussed and examples are given of rebuilding parts or coating surfaces of machinery parts. A rough machine cut is used to advantage in preparing work for metal spraying in place of sand blasting. Both babbitt and Cu-Pb bearings can now be sprayed in place of being cast. BWG (8e)

Attractive Finish Helps Metal Products Sales. 31—Tin Plate Today and Tomorrow. Herbert R. Simonds. *Iron Age*, Vol. 135, Feb. 14, 1935, pages 20-25. Describes some features in Sn plate manufacture and suggests some new applications. Future trends and possible improvements both in quality and in processing of Sn plate are discussed. VSP (8e)

A.S.T.M. ANNUAL MEETING

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* * *

See pages 167,168 for List of Exhibitors and papers of metallurgical interest.

9. TESTING

A New Surface Extensometer. T. W. K. CLARKE. *Journal of Scientific Instruments,* Vol. 12, Mar. 1935, pages 84-91. The instrument is capable of measuring surface extension to about one-millionth of an inch over a range of 0.0014", on a gage length of 0.2". This enables stresses in plate work, etc., which may vary from their maximum value to zero in 1", or even less to be measured to within 1%, and measurements to be made close to edges and their obstructions. Readings are not affected by tilting of the surface under measurement or by motion normal to it. A collimating telescope with micrometer eyepiece and illuminated slit is used to measure a slight variation in the angle between 2 small mirrors nearly at right angles. These 2 mirrors are attached to a small bar having 2 legs one of which is rigidly fixed, and the other hinged to it. The ends of these legs form the gage points. Springs for the attachment of the extensometer to plates or bars are shown; effects of vibration and diffraction are noted and reference is made to the friction and penetration of the gage points. RAW (9)

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Crack Detection. P. L. ROBERTS. *Welder,* Vol. 7, Feb. 1935, pages 459-460. Finest cracks, even those normally not visible to the naked eye or with a hand microscope, can be made visible immediately by filing the surface lightly when the filings will outline the crack like the fringe of a beard. It was found practical to use a mixture of fine Fe filings and paraffin which is washed over the surface to be examined, and the magnetic field intensified or produced by a small permanent horseshoe magnet. Several methods of applying the filing detector on finished parts without destroying them are described. Ha (9a)

Quality and Defects of Sovietistic Tool Steel from the Standpoint of Its Consumers. N. T. GOUDTZOV. *Alloy Steel,* No. 3, 1933, pages 14-17. In Russian. A brief classification of the defects of alloy tool steel. (9a)

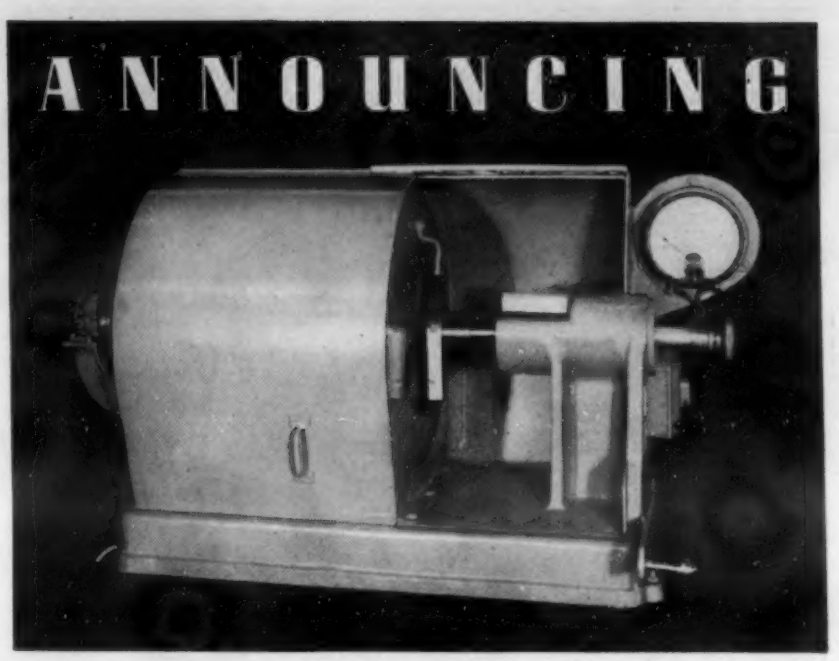
Possibilities of Measuring Elastic Stresses with X-Rays (Critische studie over die mogelijkheden van het meten van elastische spanningen met röntgenstralen). H. B. DORGERLOH & J. E. DE GRAAF. *De Ingenieur,* Vol. 50, Feb. 22, 1935, pages E 31-E 35. The mechanism of lattice deformation by stresses and the principles of detecting these deformations by X-ray diffraction are explained and illustrated by photographs. Formulas for the calculation of stresses are derived. Ha (9a)

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Bend-tension Method, a New Test for Materials (Das Biege-Zug-Verfahren, Ein neues technologisches Prüfverfahren für Werkstoffe). EWALD BUSCHMANN. *Zeitschrift für Metallkunde,* Vol. 26, Dec. 1934, pages 274-279. A testing machine, in which a sheet or wire specimen may be bent back and forth through a fixed angle (180°), at a fixed rate, while being subjected to a controlled tensile load, is described. The test is run to the failure of the specimen, measuring the number of oscillations, the load, the elongation, and the reduction of area. A discontinuity occurs in the curve of load versus elongation, plotted from these data, which is shown to mark the fatigue limit of the metal. A close agreement between the values of ultimate strength and the fatigue limit determined by the bend-tension and the usual procedures is demonstrated for the metals: Cu, Al, Ag, Zn, Fe, brass, Tombac, and Ag-Cu alloys. FNR (9b)

Meaning of the Modulus of Elasticity of Cast Iron (Sur la Signification du Module d'Élasticité de la Fonte). GUSTAV MEYERSBERG. *La Fonte,* No. 14, 1934, pages 522-532. The graphite in cast iron diminishes the section available for carrying the load, changes the direction and length of the lines of force through the specimen, and localizes the stress in certain spots. The shape of the graphite is changed under heavy loading. The tangent at the origin of the stress-strain curve and the relation of permanent deformation to total deformations are both values of interest. 7 references. WHS (9b)



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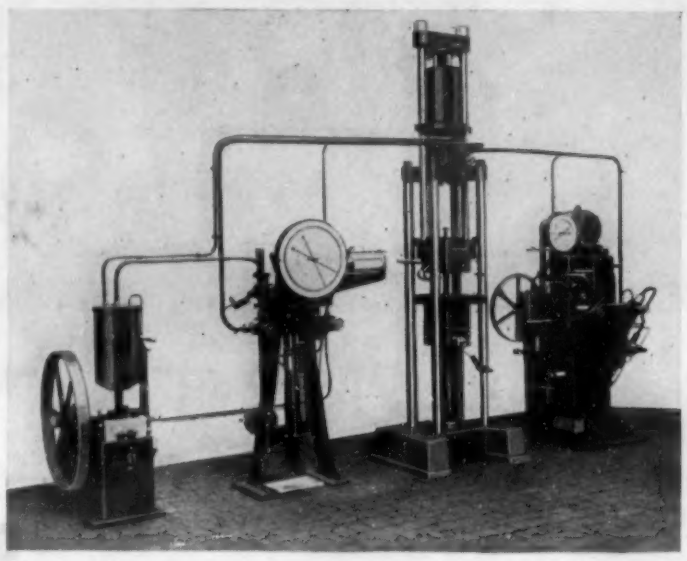

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1 — **Methods of Testing. Report of A. S. T. M. Committee E-1.** W. H. Fulweiler, Chairman. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 553-561. Progress report. **Appendix, Discussion on Use of the Tension Test for Judging the Suitability of Sheet Metals for Various Purposes**, pages 563-570. A round-table discussion summarized by the following statement. "The tension test is useful: (1) as an inspection tool; (2) as a basis for engineering design data; (3) as a basis for making changes in fabrication; and (4) as a basis for specifications. In all cases it should be used in conjunction with chemical analysis, grain size, gage uniformity, and surface finish." 16 references. VVK (9b)

2 — **The Lower Yield Point in Mild Steel.** B. P. Haigh. *Engineering*, Vol. 138, Nov. 2, 1934, pages 461-464; Nov. 16, 1934, pages 544-545. From paper read before Section G of the British Association for the Advancement of Science, Aberdeen, Sept. 12, 1934. See also *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 112. LFM (9b)

3 — **Tensile Tests of Cast Iron and Their Evaluation by Means of Mohr's Theory with Enveloping Parabola (Festigkeitsversuche an Gusseisen und deren Auswertung mittels der Mohrschen Theorie mit Hüllparabel).** A. Leon & A. Slattenschek. *Die Giesserei*, Vol. 27, Dec. 21, 1934, pages 542-548. The usefulness of Mohr's test was experimentally investigated by tensile and compressive tests. The ratio of compressive to tensile strength is calculated from the inclination of the fractured surface. 3 ranges of fractures are distinguished according to the forces which are instrumental in bringing about fracture. The tests are described in full to show the application of the theory. Ha (9b)

4 — **Pendulum Elasticity Meter, The Rolland (Elasticimetre pendulaire Le Rolland).** P. le Rolland. *Usine*, Vol. 44, Mar. 14, 1935, page 29. Discusses a new method to determine elasticity of a material which is based on the principle of the sympathetic pendulum; according to the physical condition of the material as support for the 2 pendulums, the oscillations of the one are transmitted more or less completely to the other. Applications for the determination of Young's modulus are described; the procedure is very simple as no tractive effort nor deformation but simply time has to be measured which can be done with any desired accuracy. Ha (9b)

5 — **Stresses in Punched Plates (Beanspruchung in gelochten Platten).** E. Siebel & E. Kopf. *Forschungsheft 369, Beilage zu Forschung auf dem Gebiete des Ingenieurwesens.* Edition B, Vol. 5, Nov.-Dec. 1934, 22 pages. Investigation of the stresses in a plate punched for riveting or other purposes has been extended to include most of the conditions encountered in boiler and pressure vessel practice. In this comprehensive study, the problem has been attacked by means of photo-elastic methods, using celluloid models, and by strain measurements. Huggenberger extensometers were used on the models. Beginning with simple one and three hole sections, a variety of combinations of hole arrangements and spacings are treated in the 72 illustrations. Several space models are used in which stress is plotted as the third dimension. The types of loadings include uniaxial and biaxial. In the case of the biaxial loadings the stress in one direction is made ½ that in the other in order to approximate the actual condition existing in a transverse joint of a boiler. A very satisfactory method for producing strain markings in an actual metal section is employed. Al alloy models are coated with a solution of rosin and benzol, and the benzol evaporated at 150° C. The model is placed in a testing machine while still warm and then allowed to cool. The strain markings, or fissures in the coating, are developed by gradual loading. Comparison of photographs of these metal models with the plotted results of photo-elastic analysis reveals close agreement of the strain markings with the directions of stress in the celluloid models. Special attention is given to the stress distribution and intensity in the headers and plates of water tube boilers. The effects of bending the plates and rolling in the tubes are considered. The high compressive stresses and plastic deformation produced by the introduction of the tubes have the beneficial effect of counteracting the tensile stress concentrations which always exist at the edges of a hole in a stressed plate. For this reason the authors recommend, under certain conditions, basing the design of such regions on the average stress in the net sections rather than upon the normally high concentrated stresses. It is pointed out that if the spacing between the holes for the water tubes is too small, the plastic action of rolling in the tubes will extend throughout the entire section and produce abnormally high stresses. RHH (9b)

6 — **Erichsen Cup-test Standards for Testing Sheet (Die Tiefungsnormen für die Blechprüfung nach Erichsen).** A. H. F. Goederitz. *Zeitschrift für Metallkunde*, Vol. 26, Sept. 1934, pages 208-210. The German, English and Austrian standards for the Erichsen cup-test are compared. A discussion is given of the application of the test to Al, brass, Cu, Fe, Ag and Zn sheet and strip, including the considerations of sheet thickness and physical state and the type of impressing tool used. 7 references, 12 charts. FNR (9b)

7 — **Fracture Stress Lines Check Value of Light Tests.** A. E. Gibson. *Steel*, Vol. 95, Dec. 17, 1934, pages 38-39. Recently a fracture occurred in the ram of a steam-hammer. Steel, which contained 0.48% C. was subjected to severe and repeated stresses for so long that in fracturing, the intensity and direction of stress were permanently recorded in the metal. Stress lines thus shown were checked against directional stress lines shown by polarized light in a celluloid model. Results support reliability of determination of stress distribution by polarized light as a guide in design. MS (9b)

8 — **Investigation of the Path of Slip in a Single Tin Crystal (Untersuchung der Schiebegleitung an Zinneinkristallen).** K. Bausch. *Zeitschrift für Physik*, Vol. 93, Feb. 7, 1935, pages 497-506. Description is given of the method of plastic deformation, the order of slipping of various atomic planes and the relative strength of each group of planes. FHC (9b)

9 — **Force Fits and Shrinkage Fits in Crank Webs and Locomotive Driving Wheels.** E. G. Coker & R. Levi. *Institution of Mechanical Engineers, Proceedings*, Vol. 127, Apr.-Nov 1934, pages 249-275. An experimental investigation was made of the stress distribution when force fits and shrinkage fits of the plane stress type are employed in engineering practice, in particular those occurring in the web of built-up crankshafts of locomotive and Diesel engines where it is shown that stresses attain very high values. Methods of measuring, influence of stresses on selections of material and on lubricating methods are discussed. Ha (9b)

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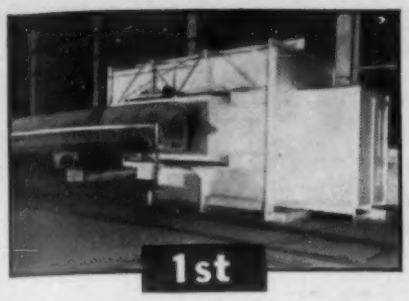

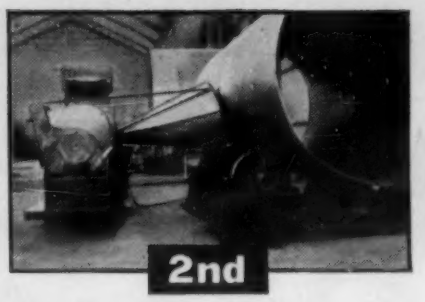

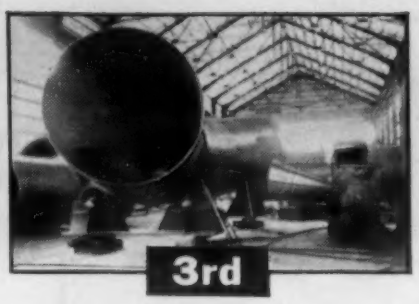

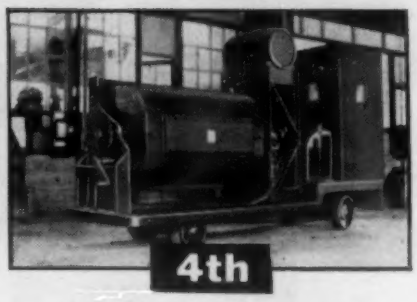

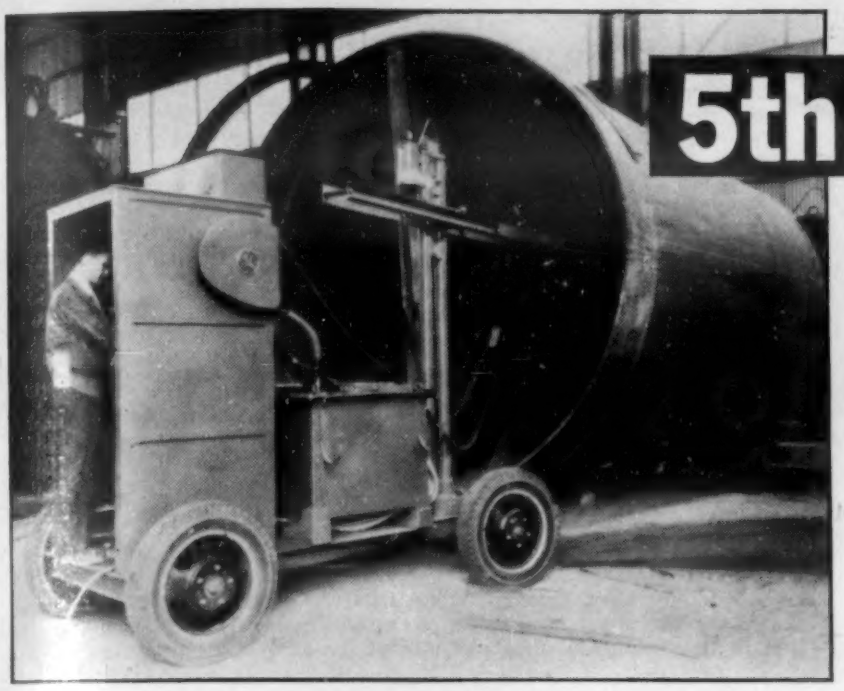

G-E INDUSTRIAL X-RAY UNIT *for* BABCOCK & WILCOX

EARLY in 1932 the Babcock & Wilcox Company installed a G-E x-ray unit in their Barberton plant, for the radiographic inspection of fusion welds in pressure vessels. It was a G-E KXC-1 — the first industrial x-ray apparatus to incorporate an x-ray tube capable of continuous operation at 300,000 volts. R. E. Hiller, of their Barberton Works Laboratory, explained their action in an article in the General Electric Review, July 1932, in which he said in part:

"The advantages and practicability of x-ray radiography as a method of nondestructive testing have been thoroughly demonstrated and proved by its rapid and wide application in many industries . . . It is sensitive to small defects, applicable to a considerable range of thickness, is simple in interpretation, furnishes ready means of locating defects, conveys assurance to the untrained as well as the trained observer, and provides a permanent record of the entire examination. The application of fusion welding to continually increasing thicknesses of steel has made it necessary to find means of examining these welds for quality, and the x-ray method has been found very suitable."

Tangible evidence of the practicability of this nondestructive testing method, and of Babcock & Wilcox's continued satisfaction with General Electric industrial x-ray apparatus for its successful application, is found in the record of their purchases of this equipment.

1st January, 1932. Initial installation of G-E x-ray equipment at Barberton Works. Model KXC-1 Unit with 300,000-volt tube operated in air.

2nd April, 1933. 300,000-volt Oil-immersed Mobile KXC-1 Unit installed at Boulder Dam for world's largest radiographic project — the inspection of over 75 miles of welded seam in pipes up to 30 feet in diameter.

3rd November, 1933. Duplication of apparatus at Boulder Dam, necessitated by stepped-up construction schedule.

4th December, 1933. 300,000-volt Oil-immersed Mobile KXC-1 installed at Barberton.

5th March, 1935. 220,000-volt Oil-immersed Mobile KXC-3 Unit added to Boulder Dam equipment.

In addition to the above, a 220,000-volt oil-immersed tube with shock-proof cables has been added to the original Barberton unit.

Your x-ray work may not assume the proportions of Babcock and Wilcox's but, whatever its nature or extent, there is General Electric apparatus to serve your needs. From delicate diffraction equipment to powerful 400,000-volt radiographic units, our line encompasses every type of industrial x-ray apparatus. Be guided by the experience of others and specify "G-E." Our Industrial Division will furnish you literature concerning any phase of industrial radiography or obligation-free assistance on a specific x-ray problem.

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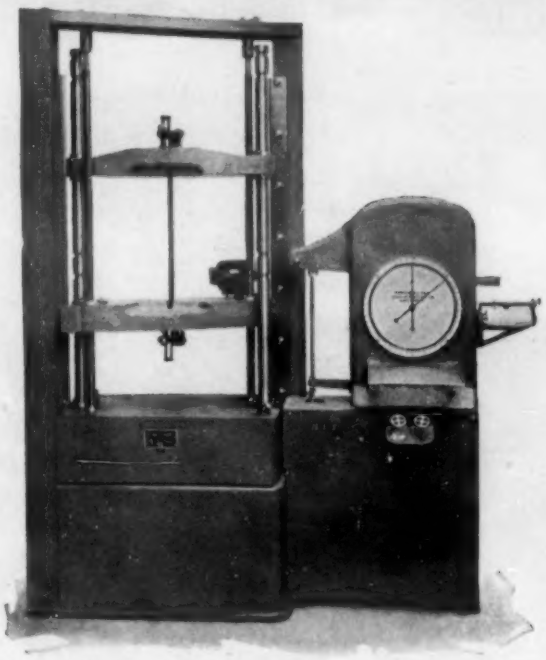

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9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals.

Fatigue Characteristics of Helical Springs. J. B. JOHNSON. *Iron Age*, Vol. 133, Mar. 15, 1934, pages 12-15; Mar. 22, 1934, pages 24-26. Gives results of tests undertaken to obtain data on commercial springs which would be of use to engineers in estimating the life of springs in service, and to metallurgists in correcting faults in fabrication. Types of metals studied were: High C acid open hearth steel, high C basic electric furnace steel, Cr-V steel, Si-Mn steel (the last two basic and made in electric furnace) and beryllium bronze. The steel springs were examined for cracks by the use of fine iron dust shaken over the magnetized surface. Fatigue tests were made on fabricated springs using a punch press with a stroke of 2⅞". Torsional fatigue tests were made on ground specimens of the metals, using an "Illinois" testing machine, and fatigue tests in reversed flexure were made on ground specimens of the metals, using a R. R. Moore machine. The most important results of the fatigue tests were as follows:

	Endurance Limit in Shearing (Stress ranging from 0 to max.-lb./in.²)		
Metal	Polished Specimen	Notched Specimen	Fabricated Spring
Acid O.H., High C.	102,000	80,000	70,000
Basic, Elec. High C.	123,000	95,000	93,000
Cr-V Steel	128,000	73,000	77,000
Si-Mn Steel	138,000	63,000	68,000
Beryllium Bronze	30,000	26,000	26,000

While the springs made of the alloy steels were the strongest, as judged by fatigue tests of polished specimens, they did not show up relatively so well in the notched-specimen tests, nor in the tests of fabricated springs. The springs of beryllium bronze showed very low notch sensitivity, and a high ratio of strength of fabricated spring to strength of polished specimens of the metal.
VSP + HFM (9c)

Influence of Chemically and Mechanically Formed Notches on Fatigue of Metals. DUNLAP J. MCADAM, JR. & ROBERT W. CLYNE. *Bureau of Standards Journal of Research*, Vol. 13, Oct. 1934, pages 527-572. An introductory section discusses the importance of stress concentration due to notches, as a cause of failure in service. Resistance of a notched specimen to fatigue and to impact many depend on entirely different properties. This paper considers the influence of notches on fatigue. Considers the effect of chemically formed notches, attention being confined to the influence of pitting caused by stressless corrosion. Relationship between tensile strength and the percentage decrease in the fatigue limit for steels and Al alloys is illustrated by composite curves. Each of these curves is presumed to represent this relationship for a notch of fairly constant effective sharpness. The 3-dimensional relationship between corrosion, percentage damage, and tensile strength is illustrated and discussed. Another object is to determine whether composite curves of similar form may be obtained by a study of experimental data obtained by a number of investigators with mechanically formed notches. The fact that such graphs have been obtained, each representing the influence of one form of notch on one kind of metal, confirms the conclusion that a stressless corrosion graph of this type represents the influence of a notch of fairly constant effective sharpness. Reasons are discussed for the deviations of individual results from the ideal composite curve for a mechanically formed notch. The relationship is considered between notch sensitivity, as measured by percentage damage, and other properties of metals. The properties considered are: Hysteresis, ductility, and work-hardening capacity. Evidence is presented that scatter of individual results in a composite graph, of the type used, is due largely to differences in tensile work-hardening capacity. Evidence is also presented that notch sensitivity, while depending somewhat on elastic hysteresis, depends largely on work-hardening capacity. The influence of notches in diminishing the advantage of superior strength is also discussed. WAT (9c)

Fatigue Tests of Butt Joints. J. ORR. *Iron & Coal Trades Review*, Vol. 130, Feb. 22, 1935, page 335. A machine was developed that can test the welded joint as made. It is a plate bending machine and tests specimens ½" thick and 1½" wide. The specimen is firmly fixed at one end and given a to and fro movement at the other end by an eccentric pin rotating at 1800 r.p.m. The stress is measured directly by a strain gage. The results compare well with the Wöhler and the Haigh testing machines. Ha (9c)

Fatigue Properties of Steel Wire. STEPHEN M. SHELTON & WILLIAM H. SWANGER. *Bureau of Standards Journal of Research*, Vol. 14, Jan. 1935, pages 17-32. Because of surface imperfections the fatigue limit of a structural member may be appreciably lower than the fatigue limit determined on machined and polished specimens of the material. This was shown by fatigue tests made by the rotating-beam method on galvanized heat-treated steel wire, Swedish valve-spring wire and cold-rolled mild steel wire. The fatigue limits of specimens with the original surfaces as produced by the manufacturers were 40, 60 and 82%, respectively, of the fatigue limits of machined and polished specimens of the same materials. The development of a suitable gripping device made possible the determination of the limiting range of pulsating tensile stresses on unmachined specimens of wire in the Haigh alternating-stress testing machine. The effect of variation of the mean stress (average of maximum and minimum stress in a cycle) between 50,000 and 200,000 lb./in.² on the limiting ranges of pulsating tensile stresses was determined on cold-drawn and galvanized, and heat-treated and galvanized, steel suspension-bridge wires, and on a high strength steel wire electroplated with Zn. The results showed that the limiting ranges of pulsating tensile stresses were practically independent of the mean stress within the range investigated. WAT (9c)

Characteristics of the Huggenberger Tensometer. R. W. VOSE. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, 1934, pages 862-873, discussion pages 874-876. The behavior of the Huggenberger Tensometer as determined by the use of a specially designed interferometer calibrator is described. It is shown that under any fixed condition of use the readings of the instrument are proportional to the motion involved, and that this factor of proportionality varies markedly with different conditions of use. The conditions covered include variations in mounting pressure, material of the specimen, balance and position of the instrument, seating on the specimen, and friction within the instrument. The accuracy of the instrument is calculated and the deviations to be expected in routine use are indicated. VVK (9b)

The Relative Rigidity of Welded and Riveted Connections. C. R. YOUNG & K. B. JACKSON. *Engineering*, Vol. 139, Jan. 25, 1935, pages 101-103. Abstract of an article published in *Canadian Journal of Research*, July 1934, pages 62-100, and Aug. 1934, pages 101-134. Gives the results of 2 series of experiments on different types of riveted and welded connections between beams or floor girders and columns. VSP (9b)

On the Effect of Slight Impurities on the Elastic Constants Particularly the Compressibility of Zinc. P. W. BRIDGMAN. *Physical Review*, Vol. 47, Mar. 1935, pages 393-397. The conclusion of Hanson that the elastic constants and particularly the compressibility of different grades of pure Zn differing only slightly in purity may differ by relatively large amounts is subjected to direct experimental test by compressibility measurements on the same grades of Zn as used by Hanson. Measurements on virgin material show no measurable difference. Apparent differences, both in compressibility and in the other elastic constants, are probably to be explained by small internal strains. Improved values are given for the compressibility of Zn. WAT (9b)

Note on the Probable Values of the Elastic Constants of the Zinc Crystal. E. P. T. TYNDALL. *Physical Review*, Vol. 47, Mar. 1935, pages 398-399. In consideration of the data on compressibility of Zn in the paper by Bridgman, *Physical Review*, Mar. 1935, pages 393-397, a somewhat different interpretation is given to the measurements by Hanson. A satisfactory set of constants for the Zn crystal may be based on Bridgman's measurements and on those obtained by Hanson on one of his lots of Zn. These constants are given in detail. WAT (9b)

Behavior of White Bearing Metals Under Deformation Tests. *Metal Industry*, London, Vol. 45, Sept. 21, 1934, pages 274, 276. Abstract of paper read before the Institute of Metals at the Autumn meeting in Manchester, Sept. 3-6. The object of the work was to obtain data for assessing the relative merits of different white metals according to laboratory tests. The experimental work, divided into 3 groups, was reported as: I,—Indentation Tests by A. S. Kenneford and Hugh O'Neill; II,—Tensile Tests by R. Arrowsmith and III,—Pounding Tests by H. Greenwood. HBG (9b)

9d. Magnetic Testing

L. REID, SECTION EDITOR

Ferromagnetism in Metallic Crystals. L. W. McKeehan. *Transactions American Institute of Mining & Metallurgical Engineers,* Vol. 111, 1934, pages 11-52. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 577. (9d)

Influence of the Magnetic Field on Watch Movements (Influence du Champ magnétique sur la Marche des Montres). A. Jaquerod & H. Mügeli. *Journal Suisse d'Horologerie,* Vol. 58, Dec. 1933, pages 192-196; Vol. 59, Jan. 1934, pages 3-8; Feb. 1934, pages 22-27; Mar. 1934, pages 43-45; June 1934, pages 90-93. The temporary and permanent influence which magnetic fields can exert on watches are investigated for different makes and materials in the movement and springs. The strength of magnetic fields required to stop watches with case and works of different metals and in different positions and also the residual values of magnetism are determined. Elinvar seems to give the best protection both against temporary and residual effects. The test results are illustrated in many curves. Protection of watches by magnetic screens or non-magnetic cases is very effective as it reduces the influence of magnetic fields to a great extent without, however, eliminating it entirely. Ha (9d)

9e. Spectrography

Chemical Spectrum Analysis in 1860 and 1935 (Die chemische Spektralanalyse 1860 und 1935). W. Gerlach, E. Riedl & W. Rollwagen. *Metallwirtschaft,* Vol. 14, Feb. 15, 1935, pages 125-132. While the relation between definite wave lengths of light and certain elements was known many years before, it was not until 1860 that the spectrum was actually used for chemical analysis by Bunsen and Kirchhoff. During the next few years several new elements were discovered by means of their spectra, but due to perfection of other analytical methods spectrum analysis has not been used extensively until the last few years. The advantages and principal methods of spectroscopic analysis are described and some of the more inmportant investigations made during recent years, especially on minerals, ores and alloys, are reviewed. 12 references. CEM (9e)

Routine Uses of Emission Spectrum Analysis in the Metal-working Industries. H. Moritz. *Engineering Progress,* Vol. 16, Feb. 1935, pages 41-43. Principles and field of use are explained, apparatus and methods described. Ha (9e)

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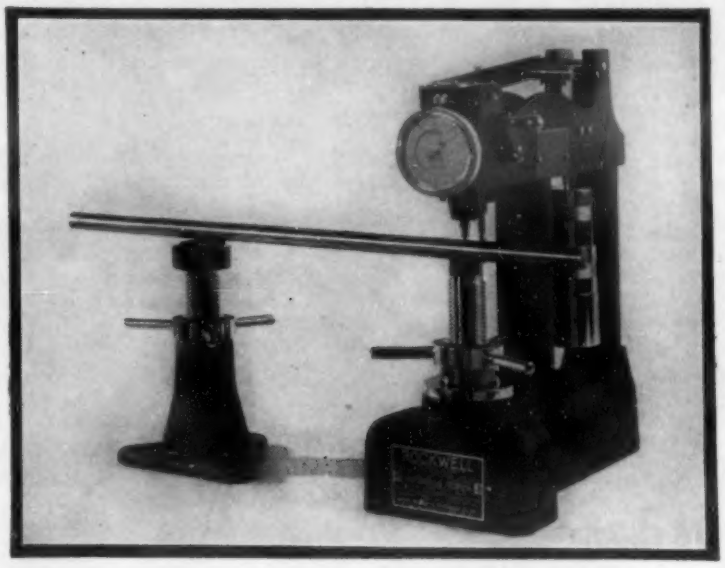

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10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

A Note on the Metallography of Ferrite in Malleable Cast Iron. H. A. Schwartz & C. H. Junge. *Transactions American Foundrymen's Association,* Vol. 5, Dec. 1934, pages 94-100. It was found that an etching solution of hot concentrated alkaline sodium picrate produced a pattern in completely graphitized malleable iron which differed from that produced by an acid etch not only in sharpness but also in that it differentiated those areas that originally were cementite and those that were austenite. Si probably is responsible for that differentiation. Temper C nodules form preferentially on the austenite-cementite interfaces. By use of the etch pattern, it is possible to show that the ferrite and temper C structure are related to the original hard iron pattern. Further, it was found that even with long-time heat treatments, Si or other elements which contribute to the etch pattern, diffuse so slowly in α and γ iron that no equalization of concentration is produced. CEJ (10)

Character of Metallic Solid Solutions and Compounds (Das Wesen der metallischen Mischkristalle und Verbindungen). U. Dehlinger. *Zeitschrift für Metallkunde,* Vol. 26, Oct. 1934, pages 227-230. A survey of present status of theory of various types of binding between atoms, with special reference to those types active in metallic solid solutions and compounds. FNR (10)

Transformations in Eutectoid Alloys (Umwandlungen in Eutektoidlegierungen). G. Wassermann. *Zeitschrift für Metallkunde,* Vol. 26, Nov. 1934, pages 256-259. Eutectoid reactions of systems Al-Cu, Cu-Sn, Cu-Be, Ag-Zn and Fe-C are compared to demonstrate analogies of microstructure, crystal structure, and mode of transformation. 19 references. FNR (10)

Diffusion of Copper in Clad Layers of Heat-treated Aluminum Alloys (Kupferdiffusion in Plattierschichten vergütbarer Aluminiumlegierungen). A. Burkhardt & G. Sachs. *Metallwirtschaft,* Vol. 14, Jan. 4, 1935, pages 1-3. Sheets of Al alloy containing 4% Cu and 2% Si, 1-mm. thick, clad with pure Al 0.05-mm. thick, were heated to 500° C. for 7, 12, and 25 min. and quenched in water. The surface was then etched off in steps of 0.005 mm. and the sheets examined by the latest X-ray method for the determination of lattice constants. The outside surface showed only the sharp lines of pure Al, a little deeper the lines diffused, indicating a diffusion of Cu alloy into the pure Al. After the diffused layer is completely etched away the sharp lines of the Al-Cu-Si alloy appear. Graphs of the lattice constants at various depths indicate that after 25 min. heating at 500° a pure Al layer slightly more than 0.02-mm. thick remained on the surface; beyond this it was contaminated with Cu. It is estimated that after 2 or 3 hours heating the Cu would diffuse to the outside surface and the corrosion protection would be lost. X-ray results were confirmed by microscopic examination and measurement which agreed closely, although they were not so accurate. CEM (10)

Pastes for Polishing Rapidly. Gordon T. Williams. *Metal Progress,* Vol. 27, Mar. 1935, pages 58, 60. Describes use of certain commercial polishing pastes and shows micrographs of specimens so polished. WLC (10)

Cast Hard Alloys. N. Zarubin & Yu. Raichlin. *Rare Metals,* No. 1, 1935, pages 31-42. In Russian. Examination of 120 samples of different hard alloys showed that fused alloys are more porous than sintered alloys. Specimens were polished with diamond dust. 37 photomicrographs. (10)

Structure of Thin Metallic Layers Produced by Cathodic Atomization or Evaporation (Zur struktur dünner Metallschichten, erzeugt durch Kathodenzerstäubung oder Verdampfung). G. Tammann. *Annalen der Physik,* Vol. 22, Feb. 1, 1935, pages 73-76. Recent investigations prove that the structure of thin metallic films is always crystalline. Due to the minute size of the particles, which are mostly monocrystals, the number of crystallization centers is very great and the distance between centers in films formed by condensation of metallic vapors on cold surfaces is about 1×10^{-15} mm. The only exception is Sb, which can be permanently in the amorphous condition in thin films if it contains 5-20% $SbCl_3$ or Sb_2Se_3. 12 references. Ha (10)

Rapid Etching of Cementite in Steels. H. S. van Klooster & Wm. J. Schaefer. *Metals & Alloys,* Vol. 6, Mar. 1935, pages 57-58. Discussion of the use of NaOH-pyrogallol solutions for etching cementite. WLC (10)

Sulphur-manganese Steels (Zur Kenntnis der Schwefel-Manganstähle). R. Vogel. *Zeitschrift für Metallkunde,* Vol. 26, Nov. 1934, pages 244-247. The structure and properties of S-Mn steels are explained on the basis of the Fe-Mn-S diagram (R. Vogel, *Archiv Eisenhüttenwesen,* Vol. 6, 1932-33, page 495). These steels consist of a solid emulsion of MnS rich MnS-FeS solid solution in a matrix of Fe-Mn solid solution. The MnS-FeS solid solution is plastic in contrast with brittle FeS. This accounts for the plasticity of high S steels to which Mn has been added. The presence of C has no influence upon the properties of the MnS-FeS constituent. FNR (10)

Growth of Zinc Containing Cadmium by the Czochralski-Gomperz Method. Harold K. Schilling. *Physics,* Vol. 6, Mar. 1935, pages 111-116. Tests were made with 0.26% Cd in Zn. The shape of the range curve was obtained for speed of growth versus orientation of crystals. Optical mosaics are found outside the range and the author found them to be the less frequent the higher the Cd content. The crystals were 2.5 to 3.3 mm. in diameter and at least 10-cm. long when grown at the speed of 1.2 cm./minute and 8-cm. long at speed of .55 cm./minute. Instead of CO_2 stream for protection of surface of melt against oxidation, the author used a small amount of solid $ZnCl_2$. WB (10)

Oxide Films on Liquid Metals Studied by Means of Electron-Diffraction. R. O. JENKINS. *Proceedings of the Physical Society*, London, Vol. 47, Jan. 1935, pages 109-124. Includes discussion. Details are given of apparatus used for photographing diffraction patterns produced by the reflection of an electron beam from the surface of molten Pb, Zn, Bi, and Sn. The thin films remaining after skimming the molten metal in vacuum consist of small, flat, oxide crystals resting on their [001] faces. Thick films were removed by fine nickel gauze from metals melted in air. The patterns obtained from these by transmitted beams showed that the chemical composition was identical with that of the thin films but that their orientation was disturbed by removal. JCC (10)

Cohesion Conditions in Pre-stretched and Pre-compressed Tensile Specimens (Ueber die Kohäsionsverhältnisse der gereckten und gedrückten Zugproben). N. N. DAWIDENKOW & E. M. SCHEWANDIN. *Zeitschrift für Metallkunde*, Vol. 26, Sept. 1934, pages 193-196. The experiments of W. Kuntze (*Mitteilungen der deutschen Materialprüfungsanstalten*, Sonderheft XIV, 1930) have been repeated, using two steels bearing 0.15-0.20% C and 0.75-0.80% C respectively, and have been extended to include a comparison of the relative tensile strengths of notch bar specimens made from pre-stretched and pre-compressed metal tested both at room temperature and at that of liquid air. In agreement with Kuntze, the strength of the pre-stretched material is found to be greater than that of the pre-compressed metal at room temperature, but at lower temperatures the relative strengths of the two are reversed, possibly because of a difference in the temperature at which brittleness sets in. It is concluded that the differences found are the result of the conditions of testing; hence, they reveal no differences in the physical state of the metal and are of no assistance in determining the ideal resistance to rupture of the metal. As a substitute for the concept of oriented microfissures put forward by Kuntze to explain the strength differences found at room temperature, a dependence upon the mechanical anisotropy of the differing preferred orientation produced by the pre-compression and pre-stretching operations is proposed. FNR (10)

The Crystallisation of Alloys. *Engineering*, Vol. 138, Dec. 14, 1934, pages 656-657. From a paper presented by C. H. Desch before the Royal Institution, London, Dec. 7, 1934. LFM (10)

Relation Between Upper Critical Points and Copper Content in Bearing Metals. A. A. BOCHVAR & V. P. ARKHIPOV. *Non-Ferrous Metals*, Vol. 9, No .1, 1935, pages 131-134. In Russian. Critical points found in bearing metals and reported before (*Non-Ferrous Metals*, Vol. 8, Nos. 2-3) were investigated in the light of their Cu content. In an alloy containing 85% Sn and 12% Sb change in Cu from 3 to 7% raised the critical point from 330° to 405° C. With 16% Sn, 16% Sb, 66% Pb change in Cu from 1.3 to 3% raised the critical from 400° to 510° C. In 42% Sn, 14% Sb and 40% Pb the increase of Cu from 3 to 7% increased the critical point from 415° to 510° C. (10)

Super-cooling of High-melting Intermetallic Compounds of Aluminum Alloys (Unterkühlung hochschmelzender intermetallischer Verbindungen von Aluminiumlegierungen). H. BOHNER. *Zeitschrift für Metallkunde*, Vol. 26, Dec. 1934, pages 268-271. The continuation under certain circumstances, of the almost linear increase of the electric resistance of Al-Ti alloys to Ti contents far in excess of the solid solubility limit is attributed to super cooling, since the phenomenon is observed in alloys cast from temperatures above the liquidus temperature, but disappears in alloys cast from temperatures within the liquid + solid region. In accord with this hypothesis, the microstructure of alloys cast at the lower temperature (720° C.) reveals free $TiAl_3$, while that of the alloys cast from a higher temperature (900° C.) exhibits only "blossoms" (apparently a type of coring). The separation of the Ti constituent from the blossoms is not induced by cold working, but is brought about in the case of alloys made from 99.0% Al by a long-time annealing at 520-540° C., or by annealing alloys made from 99.99% Al at 640° C. It is concluded that the Ti separates as a ternary or quaternary compound with the impurities of Fe and Si in the alloy of technical Al, as is also the case with alloys containing additions of Mn. 14 micrographs, 8 references. FNR (10)

Investigation of Metal Mechanics by Means of Model Substances (Untersuchungen an Modellstoffen zur Metallmechanik). A. SMEKAL. *Zeitschrift für Metallkunde*, Vol. 26, Oct. 1934, pages 220-224. With discussion. Because of the basic similarity between the mechanical properties and the response to deformational forces of salt crystals and metal crystals the former can be advantageously employed for the study of the mechanics of the latter. Rock salt offers for this purpose the advantages of transparency, a high degree of purity, and a convenient temperature of transition from the cleaving to the plastic response to deformational forces. The elastic limit and yield point, in compression, of rock salt crystals and crystals of $NaCl$-$SrCl_2$ solid solution were studied using photochemical coloring as an indicator of the stress distribution. The process of recrystallization was investigated with respect to the influence of temperature, time, the presence of nuclei, and the mechanism of grain growth operative. 12 references. FNR (10)

Magnetic Induction in a Supra-Conducting Lead Crystal. G. N. RJABININ & L. W. SHUBNIKOW. *Nature*, Vol. 135, Jan. 19, 1935, page 108. The transition from the supra-conducting phase to the ordinary phase in single crystals of Pb occurs rapidly; the transition from ordinary to supra-conducting phases occurs more slowly. CSB (10)

Decomposition of an Iron-aluminum Alloy (Über den Zerfall einer Eisen-Aluminium-Legierung). F. ROLL. *Zeitschrift für Metallkunde*, Vol. 26, Sept. 1934, pages 210-211. Alloys made of Fe, C, and 25-50% Al have been found to decompose in air, falling to a fine gray powder. Moisture in the air accelerates the decomposition. The presence of Cu or Si in the alloy depresses the minimum limit of Al required for the action. A microscopic study indicated that the decomposition proceeds with the formation of fissures along certain crystallographic planes in the metal crystals and is accompanied by the evolution of hydrocarbon gases. Acetylene was identified as one of the gases released. FNR (10)

Mechanism of Electric Conduction (Zum Mechanismus der Elektrizitätsleitung). R. W. POHL. *Zeitschrift für Metallkunde*, Vol. 26, Oct. 1934, pages 217-219. A semi-popular review of recent work on the conduction of electricity in salt crystals. 15 references. FNR (10)

1 **Thermal Disintegration of the Iron Carbide Fe_3C (Ueber den thermischen Zerfall des Eisenkarbides Fe_3C).** G. NAESER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung Düsseldorf*, Vol. 16, No. 19, 1934, pages 211-212. Disintegration of Fe_3C was determined by observing the behavior of cementite in a magnetic field as function of temperature. Disintegration begins between 1050° and 1060° C. Ha (10)

2 **Platinum-antimony Alloys.** V. A. NEMILOV & H. M. VORONOV. *Transactions of Platinum Institute*, No. 12, 1935, pages 16-25. In Russian. Pt added to Sb up to 33.3 at .1% increases its melting point to 1210° C., which corresponds to $PtSb_2$. In the interval 33.3-50 at.% Pt, crystals of $PtSb_2$ react at about 1040° C. with the molten phase, forming PtSb. This substance melts with a partial decomposition at 1040° C. and has a transformation of an unknown nature at 660° C. Eutectic crystallizes at 630° C. and corresponds to 66.3 at .% Pt. On the right branch of the liquidus curve, measurements were made only to 84.4 at. % Pt. Pt-rich phase precipitating here reacts with the liquid phase at 750° C. forming an unstable compound which transforms at 670° C. It could be PtSb. Constitutional diagram is given. Hardness of Pt increases upon Sb addition to 140 Brinell at 85 at.% Pt and then drops, having another maximum at 55 at.% Pt. Alloys produced were quite brittle. Electric resistivity reaches a maximum of 270 microhms/em.$_3$ with 27 at.% Pt. 12 photomicrographs are given. (10)

3 **Troostite, Sorbite, Pearlite.** V. KOSELEV & F. POBORIL. *Metal Progress*, Vol. 27, Mar. 1935, pages 56-58. Discussion of metallographic terminology. WLC (10)

4 **Material Transformations and Their Inhibitors (Stoffliche Umwandlungen und ihre Hemmungen).** E. LANGE. *Zeitschrift für Elektrochemie*, Vol. 41, Feb. 1935, pages 107-111. Two tables are presented for the correlation of material structure and physical, chemical, and physical-chemical laws regarding the structure. The groupings in the table are according to the various units of aggregation by which the material may be defined such as protons, atoms, molecules, single homogeneous phase and heterogeneous, polyphase structure. The energy range for transformations in terms of the threshold voltage required to bring about changes in atomic, molecular and phase aggregation is indicated. From his table the author defines stability of unstable materials, such as passive film on active metal, as an inhibition of molecular change. WB (10)

5 **Preparation of Thin Silver Monocrystals and Their Examination by Electron Rays (Herstellung von dünnen Silbereinkristallen und ihre Untersuchung mit Elektronenstrahlen).** H. LASSEN & L. BRUEK. *Annalen der Physik*, Vol. 22, Feb. 1, 1935, pages 65-72. Very thin Ag foils were condensed in a high vacuum on rocksalt. The orientation and formation of the Ag monocrystal depends on the orientation and temperature of the rocksalt. Ha (10)

6 **Alloys of Aluminum with Gallium (Die Legierungen des Aluminiums mit dem Gallium).** ERNST JENCKEL. *Zeitschrift für Metallkunde*, Vol. 26, Nov. 1934, pages 249-250. With discussion. The constitutional diagram of the system Al-Ga (previously outlined by Puschin and Stajic, *Zeitschift für anorganische und allgemeine Chemie*, Vol. 216, 1933, page 26) has been reinvestigated by thermal, X-ray, and microscopic methods. The liquidus curve extends unbroken from the melting point of pure Al to an Al-Ga eutectic near 100% Ga and 26.3° C. By an extrapolation to zero time of a plot of the time of the eutectic arrest versus concentration, the limit of solubility of Ga in solid Al was established at 13% Ga. The solid solubility limit could not be confirmed by lattice parameter measurements because of the small difference between the atom radii of Al and Ga. A eutectic structure was seen microscopically and lines of Ga and Al were found on photograms of alloys containing 20% and more of Ga. In discussion, Röhrig gave electric conductivity data and evidence from corrosion studies to show that there is no solid solubility of Ga in Al. FNR (10)

7 **Constitutional Diagram of the System Copper-gallium (Das Zustandsdiagram des Systems Kupfer-Gallium).** FRIEDRICH WEIBKE. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 220, Nov. 17, 1934, pages 293-311. The Cu-Ga diagram and its interpretation are augmented by photomicrographs. WB (10)

8 **Use of Radioactive Alloys in Metallography (Die Anwendung der radioaktiven Legierungen in der Metallkunde).** O. WERNER. *Zeitschrift für Metallkunde*, Vol. 26, Dec. 1934, pages 265-268. With discussion. It is shown that the rate of emission from an alloy of Tl, Zn, (Zn-Ba) or Al with Ra or ThX is influenced by the grain size, crystal lattice type, degree of strain, and temperature, as well as by the identity of the metal involved. The activity of emission increases with rising temperature, most rapidly in the case of Tl, and most slowly in the case of Al. This difference is attributed to the lattice types of Tl, Zn and Al. A discontinuity in the rate of change of emission with changing temperature occurring at 235° C. in the case of Tl is associated with the allotropic transformation. Upon subjecting the alloys to cold working the rate of emission first increases and then with further deformation (in excess of 20% in the case of Zn) it decreases. This change is shown to parallel the change in density of the metal upon working. The measurement of the activity of emission with increasing annealing temperatures subsequent to cold deformation reveals a discontinuity at a temperature which can be associated with that of recovery. The correlation is very close in the case of Zn, but less so in the case of Al. 9 references. FNR (10)

9

10 **Metallographic Films (Metallographische Filme).** H. J. WIESTER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Jan. 5, 1935, pages 7-11. Some recent arrangements are described which made possible the demonstration by moving pictures of metallographic phenomena, as recrystallization processes, austenite-martensite transformation, $\alpha - \gamma$ transformations in pure Fe, and surface hardening. The technique is described in detail. Ha (10)

A Method for Studying the Thermal Expansion of Steels. YA. A. TROTZKII & E. G. SHVIDKOVSKII. *Zavodskaya Laboratoriya*, Vol. 3, Dec. 1934, pages 1092-1101. The preliminary communication is confined to a review of the existing methods with over 40 literature references and a brief description of a proposed simplified dilatometer. Chas. Blanc (10)

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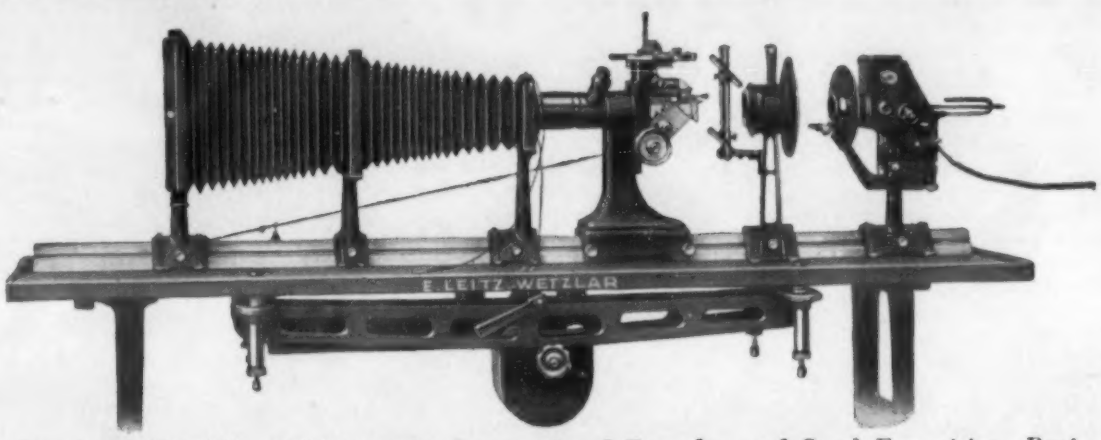

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Grain-size in Metals, with Special Reference to Grain Growth in Austenite. M. A. Grossmann. *Transactions American Society for Metals*, Vol. 22, Dec. 1934, pages 861-878. 15 references. Paper read and discussed at Grain-size Symposium, A.S.M. Convention, 1934. Presents data showing that previous heat treatment and hot work affect the austenite grain size and the temperature of coarsening of this grain size in low C steels. Steels studied were S.A.E. 1020, 4615 and 3135. Data show that rate of passing through the transformation point is without effect upon austenite grain size. WLC (10)

X-Ray Investigation of the Mechanism of the Transformation from Face-Centered Cubic Lattice to Body-Centered Cubic. Zenji Nishiyama. *Kinzoku no Kenkyu*, Vol. 11, Dec. 1934, pages 561-589. In Japanese; *Science Reports Tohoku University*, Vol. 23, 1934, pages 637-664. In English. The mechanism of the transformation from face-centered-cubic lattice (γ) to body-centered cubic (α) was investigated by X-rays. The specimen was a γ single crystal of Fe-Ni alloy containing 29.90% Ni. It was transformed into α by cooling in liquid nitrogen. X-ray patterns were taken of the specimen before and after transformation, and it was confirmed that a single γ crystal is split up into a large number of α crystals, the orientation of which has a certain relation to that of the parent crystal. The above result cannot be explained by Bain's or Kurdjumow-Sachs' theory, and hence the following mechanism is proposed. The transformation takes place by shear in the plane γ (111) in the direction γ ($\bar{2}11$), expansion and contraction being also added, until

$$\gamma(111) \longrightarrow \alpha(011)$$

and $\alpha[\bar{2}11] \longrightarrow \alpha[01\bar{1}]$, that is, γ $(011) \longrightarrow \alpha(100)$.

The possible number of these shears is 12, which is also the number of orientations of transformed minute α crystals. It was found by experiment that the distribution of these orientations was affected by the form of the specimen. The specimen, consisting of α crystals produced from a single γ crystal, was brought back to the γ state of the original orientation by heating it below the recrystallization temperature. KT (10)

X-ray Analysis of the β Phases of Cu-Be and Al-Zn Alloys at High Temperatures (Röntgenanalyse der β -Phasen der Cu-Be-und Al-Zn-Legierungen bei hohen Temperaturen). G. F. Kossolapow & A. K. Trapesnikow. *Metallwirtschaft*, Vol. 14, Jan. 18, 1935, pages 45-46. A Cu-Be alloy containing 7.2% Be showed at room temperature 2 systems of lines in Debye exposures, α and γ, and regular atomic arrangement. The intensity of the α phase was greater than that of the γ phase. Both phases appeared up to 570°C. at 620° the α lines disappeared and a line system of the body-centered-cubic β phase alone appeared, without any superstructure lines. The lattice constant of the β phase was almost the same as that of the γ phase at low temperatures. Apparently β has the same structure as γ, except that it has random orientation. At 750° this alloy was pure β with $a = 2.79$ A.U., again with random orientation. At 800° the lines were not sharp enough for evaluation. These results indicate the α to γ transformation does not pass through the β phase. The alloy 40% Al, 60% Zn, showed lines of Al and Zn at room temperature, at 345° two face-centered-cubic lattices whose constants differed by only .66%. At 410° only one lattice was found. An alloy with 22.8% Al had only one face-centered-cubic lattice at 345°. CEM (10)

Hardness and Lattice-distortion of Cold-rolled α-Brass. W. A. Wood. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Vol. 19, Feb. 1935, pages 219-230. The X-ray spectra of cold-rolled α-brass of same composition but of different hardness show a difference in the breadth of the lines. The increase in breadth is found to be proportional to the increase in hardness of the brass and the broadening is due to distortion of the lattice which is caused by the unit cell of brass ceasing to be cubic after the material has been cold-worked. 11 references. Ha (10)

6

—— **Notes on the Cadmium-nickel System.** Carl E. Swartz & Albert J. Phillips. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 333-336. See *Metals & Alloys*, Vol. 5, May 1934, page MA 214. (10)

7 **X-ray Study of Orientation Changes in Cold-rolled Single Crystals of Alpha Brass.** Carl H. Samans. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 119-134. Includes discussion. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 28. (10)

—— **The Metastability of Cementite.** H. A. Schwartz. *Transactions American Society for Metals*, Vol. 23, Mar. 1935, pages 126-156. Paper read and discussed at A.S.M. Convention, 1934. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 30. WLC (10)

8 **Magnetic Transformation in Carbon Steels During Quenching.** I. N. Zavarine. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 113, 1934, pages 190-202. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 579. (10)

—— **Diffusions That Take Place in Iron-silicon Alloys During Heat Treatment.** N. A. Ziegler. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 113, 1934, pages 179-189. Includes discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 282. (10)

9 **X-ray Study of the Action of Aluminum During Nitride Hardening.** John T. Norton. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 113, 1934, pages 262-272. Includes discussion. See *Metals & Alloys*, Vol. 5, July 1934, page MA 351. (10)

—— **Solubility of Oxygen in Solid Copper.** F. N. Rhines & C. H. Mathewson. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 337-353. See *Metals & Alloys*, Vol. 5, June 1934, page MA 282. (10)

10 **Effect of Quenching Strains on Lattice Parameter and Hardness Values of High-purity Aluminum-copper Alloys.** Arthur Phillips & R. M. Brick. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 94-118. Includes discussion. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 581. (10)

11. PROPERTIES OF METALS AND ALLOYS

Metals of High Purity. A. Portevin. *Metal Progress*, Vol. 27, Mar. 1935, pages 66, 68. Discusses the changes in properties of metals due to their purity such as the extreme malleability of very pure gold, increased ductility of Mg and Ca due to greater purity, and increased resistance to corrosion of Fe, Mg and Al due to high purity. WLC (11)

A Metallurgical Survey of Engineering Materials. Josiah W. Jones. *Journal of the Institution of Production Engineers*, Vol. 14, Jan. 1935, pages 21-41. Includes discussion. Subjects dealt with include the strength-to-weight ratio of high elastic-limit alloy steels and modern light alloys, the "shapeability" of metals, the age hardening of Duralumin, the properties of the "Kunial" age hardening copper alloys, defects in metals, and the choice of metals to resist corrosion or to work at high temperatures. The materials chosen by different designers for the parts of high speed Diesel engines are listed. JCC (11)

The Velocity of Sound in Sheet Materials. A. B. Wood & F. D. Smith. *Proceedings of the Physical Society*, London, Vol. 47, Jan. 1935, pages 149-152. Includes discussion. The velocity of sound in sheets of iron, brass, lead, and other materials has been determined by measurements of the spacing of the nodes of Chladni's figures. These may be produced at frequencies up to 20,000 by means of magnetostrictively-excited nickel tubes. JCC (11)

Titanium in Alloys (Titanium i Legeringar). *Teknisk Tidskrift*, Vol. 65, Mar. 9, 1935, page 84. See "New Role of Titanium in Steels and Alloys," *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 119. BHS (11)

Electrical Resistance of Co in a Longitudinal Magnetic Field (Der Elektrische Widerstand des Kobalts in Longitudinalen Magnetfeld). Md. Sharf Alam. *Zeitschrift für Physik*, Vol. 93, Feb. 7, 1935, pages 556-560. Variations in the electrical resistance of Co were measured by the Thomson duplex bridge method. The resistance of Co increases with increasing magnetic field up to a saturation value which occurs when saturation of the magnetization value takes place. FHC (11)

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Light Metals and Alloys, Cast and Wrought. Report of A. S. T. M. Committee B-7. J. B. Johnson, Chairman. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 272-276. Progress report. **Appendix. Service Characteristics of the Light Metals and Their Alloys**, pages 277-306. This report was prepared for the purpose of presenting to the engineer, in a brief and concise form, essential data for Al and Mg and their alloys. It is arranged in four parts: metallurgical characteristics, industrial requirements, surface protection, and tabular data. The tabular data include trade designations of cast and wrought Al and Mg alloys, nominal compositions, physical and mechanical properties and foundry characteristics. A selected list of 26 references covering the period 1924 to 1934 is added. VVK (11a)

Gold-Chromium Resistance Alloys. James L. Thomas. *Bureau of Standards Journal of Research*, Vol. 13, Nov. 1934, pages 681-690. The addition of from 1.6 to 2.4% or more of Cr to Au produces alloys having very small temperature coefficients of electrical resistance. In particular, 2.1% Cr in Au gives an alloy the resistance of which is independent of temperature, to a few parts in 10 million, in at least the interval 20° to 30° C. These alloys were also exceptionally stable in resistance. They, however, have a thermoelectric power against Cu which is 3 or 4 times as large as that of manganin. The preparation and heat treatment of some of these alloys are described. WAT (11a)

Internal Pressure Stress in Lead Pipes. Heinz Bablik & J. Krystof. *Metal Industry*, London, Vol. 45, July 6, 1934, pages 3-6. The substitution of ternary Pb alloy pipe in the water mains of Vienna and Budapest made necessary the development of specifications for this material. The authors indicate their methods for calculating the internal pressures and their methods of testing pipe so that the loading is never great enough to cause 0.2% increase in internal diameter. They endeavored to establish a relation between max. loading pressure which can be imposed on the Pb pipe and (1) chemical composition of the metal used and (2) the ratio of wall thickness to inside diameter. The metals used were pure lead and a lead alloy known as British Non-Ferrous ternary alloy No. 1. The effect of heat treatment was studied. The authors found that the critical hydraulic pressure tubes must withstand is the pressure of repulsion plus static water pressure; that for correct testing the hydraulic pressure which causes an increase of 0.2% in internal diameter, rather than ultimate pressure, must be determined: that it would not be commercially economical to have the ratio of wall thickness to inside diameter greater than 0.6; that increased hydraulic resistance can be effected by alloying and heat treatment; and that the B.N.F. ternary No. 1 is far superior to pure Pb. HBG (11a)

Magnetic Susceptibility of Some Alloys of "Gamma-Brass" Structure. Cyril Stanley Smith. *Physics*, Vol. 6, Jan. 1935, pages 47-52. Alloys of Cu-Zn, Cu-Cd, Ag-Zn, Ag-Cd were investigated. Magnetic susceptibility results are tabulated and plotted against electron ratio. Across the $\beta + \gamma$ range there is very little change in susceptibility. There is an increase in electron ratio across the homogeneous γ phase where an increase in diamagnetism occurs. At the next phase appearing, diamagnetism decreases again. Diamagnetism is dependent upon the number of free electrons and the strongest diamagnetism is at the limit of the γ phase with the highest possible electron ratio for the structure. WB (11a)

Alpha and Alpha + Beta Silico-Cast Brass (Ueber α und $\alpha + \beta$ Silico-Gussmessing). Max Koehler. *Thesis, Technical University Aachen*, 1934, pages 1-52. The effect of Si on physical and chemical properties of brasses (Cu-Zn alloys, in particular on the α and α-β phases, was investigated and the contradictions found in literature elucidated. Si is not a harmful constituent in brass; the ternary alloys Cu-Zn-Si are generally greatly superior to the Cu-Sn bronzes. Cast brass of composition 80/20 has the best tensile strength at 4.5% Si; with more than 6% Si the material becomes brittle. The best practical material has 3-3.5% Si with a tensile strength of 47 kg./mm.², elongation of 38%, and 9.5 mkg./cm.² notch-toughness. The 70/30 α-brass has a saturation value of 1.1-1.2% Si. The properties are not quite as good as those of 80/20. The 60/40 brass is hardened even with very small additions of Si; with 2.4% a Brinell hardness of 300 is obtained, the highest known of any alloy with Cu base. Notch-toughness is higher than for 70/30 brass. The 60/40 brass with low Si is an excellent construction material combining great strength, hardness and satisfactory notch-toughness. Si brasses are sufficiently resistant against mineral acids and bases, increased Si content increases corrosion resistance. They do not have a good resistance against ammonia. Si brasses should not be used for parts attacked by sea water. They are fully equivalent to bronzes. Si brasses give good bearing metals which are equivalent to the best Sn bronzes and are much superior to the latter in heavily stressed roll bearings. It was found that no silicide is formed as a new phase. The rule of Guillet was confirmed, the equivalent value of Si is 10 except for the $\beta/\beta + \alpha$ saturation limit in 60/40 brasses where it is 13. The tests are described in full. The resistance against HCl, H_2SO_4, H_3PO_4, KOH, NH_4OH, $Na_2S_2O_3$, Na_2CO_3, Na_2SO_4 and sea water was not influenced by annealing (homogenization). 17 references. Ha (11a)

The Surface Tension of Molten Lead Alloys Under Oxidizing Conditions. H. Vance White. *Metals & Alloys*, Vol. 6, Mar. 1935, pages 53-56. 8 references. Quick method of determining surface tension is described in which metal head necessary to force metal into a narrow groove is measured. Surface tension $= \frac{\text{metal head x density x groove width x g}}{2}$. Data are presented giving surface tensions of linotype and monotype metal. Zn and Na have very marked effects upon surface tension; Zn increases it and Na decreases it when present even in small amounts. Effects on surface tension of oxidation, and of various impurities and additions to Pb alloys are shown in tabulated data. WLC (11a)

Osmium-Iridium. O. E. Zviagintzev & B. K. Brunovski. *Transactions of Platinum Institute*, No. 12, 1935, pages 5-15. In Russian. Natural crystals of Os-Ir alloy were studied by means of X-rays. On most photographs crystals showed striations associated with cold work and dissociation of the original single crystal into many subsidiary ones. This is explained on the basis of geological transformations to which the crystals were subjected. Discrepancy between the structure obtained by the authors and by G. Aminov and G. Phragmen (*Zeitschrift für Krystallographie*, Vol. 56, 1921, pages 510-519) is explained. (11a)

Effect of Cold-Rolling on the Indentation Hardness of Copper. John G. Thompson. *Bureau of Standards Journal of Research*, Vol. 13, Nov. 1934, pages 745-756. Specimens of tough-pitch electrolytic Cu, commercial O-free Cu, and single crystals of Cu of different orientations, were subjected to severe cold-rolling to determine the effect on the properties, particularly on the hardness. In all cases the indentation hardness increased to a maximum value which was maintained during subsequent reduction until the hardness determinations became unreliable owing to the thinness of the specimens. The results were confirmed by determinations of tensile strength of some of the specimens and by the application of Meyer's analysis to some of the data. The effect of severe cold-rolling on the indentation hardness of Cu was not materially affected by the initial thickness of the specimen, the presence or absence of 0.04% of O, the change from polycrystalline to single crystal specimens, or the orientation of the single crystals with respect to the plane of deformation. WAT (11a)

Measurement of Viscosity of Alkali Metals in Vacuum (Die Messung der Viskosität der Alkalimetalle im Vakuum). F. Sauerwald. *Zeitschrift für Metallkunde*, Vol. 26, Nov. 1934, pages 259-260. Apparatus for measurement of viscosity of liquid metals under a controlled atmosphere is described. Determinations made with this equipment give the following values of the viscosity (η): Na = 0.0077, K = 0.0056 and from previously published work (*Zeitschrift für anorganische und allgemeine Chemie*, Vol. 203, 1931, page 156) Cu = 0.038, Zn = 0.0345, Ag = 0.032, Pb = 0.028, Cd = 0.025, Sb = 0.024, Bi = 0.023, Hg = 0.021, and Sn = 0.020. All of these measured values are shown to agree closely with the values calculated by C. Andrade (*Philosophical Magazine*, Vol. (7) 17, 1934, page 497). FNR (11a)

Further Experiments with the Magnetic Cooling Method. N. Kürti & F. Simon. *Nature*, Vol. 135, Jan. 5, 1935, page 31. Temperatures of 0.04° K. have been reached by the magnetic cooling method applied to iron alum. Zr is found to be supra-conducting below 0.70° K.; Hf below about 0.3° K.; Cu, Au, Ge, Bi, and Mg did not become supra-conducting down to 0.05° K. CSB (11a)

Systematic Doctrines of Affinity. 63. The System Rhenium-Phosphorous (Beiträge zur systematischen Verwandtschaftslehre. 63. Das System Rhenium-Phosphor.) Haakon Haraldsen. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 221, Jan. 28, 1935, pages 397-417. It is difficult to bring Re and P to reaction, which only occurs above 800° C. Finely powdered Re was used which was reduced from K-perrhenate. Red P and Re were heated in evacuated and sealed quartz tube to above 800° C. where the ReP compounds began to form. The stable compounds were investigated by means of tensimetric analysis. X-ray corroboration was obtained for the compounds ReP_2, ReP_3, ReP, and Re_2P. Molecular volume, dissociation pressures, heats of formation were determined for the compounds and compared with their affinities. WB (11a)

Magnetism of Tin. K. Honda & Y. Shimizu. *Nature*, Vol. 135, Jan. 19, 1935, page 108. A discussion of the reason for white Sn changing from para- to diamagnetic when cold worked or reduced to a colloidal powder. Authors postulate that it is correlated with a different atomic spacing in the colloidal and cold worked states than in the normal state. CSB (11a)

Influence of a Third Constituent on Ageing of Binary Systems. B. Gridnev & G. Kurdyumov. *Domes*, No. 11-12, 1934, pages 61-65. In Russian. Cu-rich corner of Cu-Al system to which 2% Ni was added was investigated microscopically, dilatometrically and by means of X-rays. Up to 8% Al alloys form solid solutions. With 9% Al a eutectoid is observed. γ phase is observed with 13% Al and is not different, from X-ray data, from that usually observed in Al-Cu alloys. Space lattice parameter changed from 3.6068 for Cu with 2% Ni to 3.6544 for Cu containing 13% Al and 2% Ni. The solubility does not change with the temperature. Constitutional diagram of the corner is given. Addition of 2% Ni shifts the eutectoid line from 570° C. to 605° C., narrows the α field from 9.8% Al to 8.6% Al. Under the eutectoid line no change in the solubility with the temperature could be found. The intermediate phase seen in specimens containing 11.5-13.0 Al and quenched from 950° C. is somewhat different from that observed in the usual Cu-Al alloys when studied from X-ray standpoint. (11a)

Direct Measurement of the Free Path of Electrons in Metals (Versuche zur direkten Ermittlung der freien Weglänge der Elektronen in Metallen). A. Eucken & F. Förster. *Zeitschrift für Metallkunde*, Vol. 26, Oct. 1934, pages 232-235. By means of a measurement of the specific electric resistance of extremely thin metal sections, the mean free path of electrons has been measured in Bi and Ag, giving a value of 11 μ for Bi and of 57.7 x 10^{-7} cm. $\pm$ 15% for Ag, both at 0° C. In the case of Bi there was found to be only one free electron for each 10^6 atoms, indicating the applicability of the classical theory in this instance. In the case of Ag, however, the Fermi-Sommerfeld theory, requiring one free electron for each atom, was shown to apply. A method for the production of extremely fine Ag wire is described. FNR (11a)

Recent Development of the Field of Noble Metal Alloys (Die jüngste Entwicklung auf dem Gebiete der Edelmetall-Legierungen). O. Feussner. *Zeitschrift für Metallkunde*, Vol. 26, Nov. 1934, pages 251-253. A general discussion of the technically useful properties of Au, Ag and Pt metals as well as of their alloys with each other and with the base metals. FNR (11a)

Diffusion of Gases through Metals. Tito Franzini. *Nature*, Vol. 135, Feb. 23, 1935, page 308. Author reports that Pd adsorbs deuterium preferentially from a mixture of hydrogen and deuterium whereas deuterium diffuses more slowly than hydrogen, through Pd. He is led to postulate an adsorption threshold on one side and an evaporation threshold on the other side of the metal, to explain the pressure dependence of diffusion. CSB (11a)

Penetration of a Magnetic Field into Supra-Conductive Alloys. W. J. de Haas & J. M. Casimir-Jonker. *Nature*, Vol. 135, Jan. 5, 1935, page 30. Alloys of Tl-Pb (65% Tl) or Tl-Bi (Bi_5Tl_3) when rendered supra-conducting by cooling below 4° K. allow electromagnetic fields above a certain critical strength to penetrate them. The temperature dependence of this critical field is given. CSB (11a)

The Impact Strength of Commercial Zinc Alloy Die Castings. E. A. Anderson & G. L. Werley. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, 1934, pages 176-181. Charpy impact test specimens, 525 in number, were cut from 77 commercial zinc-alloy die castings and subjected to impact tests in comparison with test bars die cast to the same size. All of the test specimens were so cut as to leave one unmachined die-cast face. In conducting the Charpy impact test, the specimens were placed in the machine in such a manner as to place this die-cast face under tension. The results obtained indicate a close agreement between the impact strength of the machined specimens and of specimens die cast to size. The authors draw no conclusion relating to the correlation of these values to the over-all strength of the original die casting. VVK (11a)

Non-Ferrous Metals and Alloys, Report of A.S.T.M. Committee B-2. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 217-220. Progress report. VVK (11a)

Recrystallization and Allotropy of Calcium (Über Rekristallisation und Allotropie von Kalzium). A. Schulze. *Zeitschrift für Metallkunde*, Vol. 26, Nov. 1934, pages 260-261. This brief résumé of an investigation of the physical constants of technical Ca (96% Ca, 1.7% N, remainder O_2, C, Fe, Na and K) presents the following information: (1) there is an allotropic transformation between 430° and 450° C. (located dilatometrically); (2) the crystal structure at 20° C. is face centered cubic; (3) the crystal structure at 450° C. is body centered cubic in impure Ca and close packed hexagonal in pure Ca (99.9%); (4) the heat-tone of transformation is 2.3 cal./g.; (5) a plot of the electrical resistance versus temperature is given for the range 0°-475° C.; (6) at temperatures below 325° C. the electrical resistance is markedly increased by cold working, but at, and above, this temperature recrystallization takes place giving the worked and annealed metals identical values of resistance. FNR (11a)

Platinum-Rhodium Alloys. V. A. Nemilov & N. M. Vorobov. *Transactions of Platinum Institute*, No. 12, 1935, pages 27-35. In Russian. Alloys were prepared in high frequency vacuum furnace. With 40 at.% Rh ingots had to be remelted to free them from blow holes. Hardness, microstructure, electric conductivity and thermoelectric force showed that the system consists of a series of solid solutions. Hardness reaches a maximum of 78 Brinell with 55% Rh, conductivity is minimum at 18.4% Rh where specific resistance is 20.40 at 25° C. and 22.42 at 100° C. Thermal e.m.f. increases with Rh content from 6.55 at 1000° C. for 10% Rh to 13.77 at 1000° C. for 100% Rh. Figures for intermediate values are given. Up to 40 at.% Rh specimen can be etched with aqua regia, above it with a molten mixture of NaCl and K_2SO_4.12 photomicrographs are reproduced. Heating to 750° C. slightly scaled the alloys, but heating at 1150° C. left them bright. Alloys with 18 to 35% Rh are very suitable for resistance elements having a melting point of about 1900° C. and operating temperature of 1600° C. together with a sufficiently high resistance. (11a)

The Creep and Fracture of Lead and Lead Alloys. H. F. Moore, B. B. Betty & C. W. Dollins. *Bulletin* No. 272, *Engineering Experiment Station*, University of Illinois, Vol. 32, Feb. 5, 1935, 47 pages. Short-time tensile tests fail to evaluate the long-time load-carrying ability of Pb and its alloys. There appears to be no load so low that deformation does not occur with time. At 200 lbs./in.² the calculated percentage deformation per year is:

	Room Temp.	150°F.
Pure Pb	0.7%	2.0%
Pb, 2% Sn	0.6%	1.3%
Pb, ¾% Sb	0.4%	1.2%
Pb, 0.04% Ca	0.3%	0.7%

Single crystals or coarse-grained Pb alloys resist creep better than polycrystalline or fine grained material. Distortion seems to occur by rotating of grains. In tests at high loads, producing fracture in some days, elongation tended to be lower than in ordinary tensile tests. This effect is less noticeable in pure than in alloyed Pb. In fatigue tests no true endurance limit was found. Stresses to give a life of 50 million cycles were

	lbs./in.²
Pure Pb	400
Pb, 2% Sn	800
Pb, ¾% Sb	1000
Pb, 0.04% Ca	1000

These stresses, exerted in one direction for a year, would cause fracture of the 3 alloys and nearly 4% extension in pure Pb. HWG (11a)

Freezing Point of Gallium. William F. Roeser & James I. Hoffman. *Bureau of Standards Journal of Research*, Vol. 13, Nov. 1934, pages 673-676. The temperature of equilibrium between liquid and solid Ga was found to be 29.780 $\pm$ 0.005° C. Four determinations on 2 different lots of metal yielded the same results. Difficulties ascribed to the undercooling and low thermal conductivity of the Ga prevented a satisfactory determination from ordinary heating and cooling curves. The temperature of equilibrium between the liquid and solid phases of the metal was obtained by measuring the temperature of an intimate mixture of the solid and the liquid. It was found that the presence of the oxide did not affect the freezing temperature, indicating that the oxide is not appreciably soluble in the metal. WAT (11a)

Special Brasses as Casting Materials (Sondermessinge als Gusswerkstoffe). Erich Becker. *Giesserei*, Vol. 28, Mar. 1, 1935, pages 108-114. Special brasses i.e. Cu-Zn alloys with additions of other elements, can in most cases replace red brass and bronze and are often superior to them. The melting process requires great attention, only pure materials should be used as even very small differences in the additions result in great changes in the mechanical properties. Best procedures of melting, pouring and molding are discussed. Curves for tensile strength are given. Ha (11a)

Die-Cast Metals and Alloys. Report of A. S. T. M. Committee B-6. H. A. Anderson, Chairman. *Proceedings American Society for Testing Material*, Vol. 34, Pt. I, 1934, pages 251-254. Progress report. **Report of Subcommittee V on Exposure and Corrosion Tests.** W. M. Peirce, Chairman. Pages 255-260. The die-cast specimens, exposed for over four years at Key West, Fla., Sandy Hook, N. J., New York, N. Y., Altoona, Pa., State College, Pa., and Rochester, N. Y. have been photographed and the zinc impact specimens which were measured before exposure have been remeasured and the change in dimensions calculated and reported in a table. Notes are also given on the appearance of the specimens. **Appendix. The Effect of Variations in Aluminum Content on the Strength and Permanence of the A. S. T. M. No. XXIII Zinc Die-Casting Alloy.** E. A. Anderson & G. L. Werley. Pages 261-269; discussion pages 270-271. Alloy No. XXIII has the analysis: Cu 0.10 max.; Al 3.5-4.5; Mg 0.03-0.08; Fe 0.100 max.; Pb 0.007 max.; Cd 0.005 max.; Sn 0.005 max.; and Zn remainder. The purpose of this study was to determine the effect of variations of Al from 4.40 to 4.80 on properties other than castability. Specimens were tested for tensile strength, tensile elongation, impact strength and dimensional change in the condition as cast and after accelerated aging exposures and aging in a normal room atmosphere. The accelerated tests used were the 95° C. steam test, and a dry air anneal at this same temperature. In both cases specimens were tested after 1, 2, 3, 5, 7, and 10 days of exposure. The maximum Al content was found to be for impact strength; as cast, 4.7% Al, 10-day anneal, 4.5% Al and 10-day steam, 4.4% Al. In tensile strength, no definite effect due to Al was noted up to 4.8%. For tensile elongation the max. Al was found to be; as cast, 4.4%, 10-day anneal, 4.5% and 10-day steam, 4.5%. For dimensional stability no serious decrease in steam resistance was noted at or below 4.7% Al. With particular consideration of the impact strength after short exposure to higher temperature, the authors recommend that the present max. of 4.5% be reduced to the lower value of 4.3% Al. VVK (11a)

The Improvement of White Metals for Severe Service. Some General Considerations. D. J. Macnaughtan. *Metal Industry*, London, Vol. 45, Sept. 21, 1934, pages 269-272; Sept. 28, 1934, pages 293-295. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 534. HBG (11a)

Internal Stresses in Quenched Aluminum and Some Aluminum Alloys. L. W. Kempf, H. L. Hopkins & E. V. Ivanso. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 158-180. Includes discussion. See *Metals & Alloys*, Vol. 5, July 1934, page MA 354. (11a)

Influence of Silver on the Softening of Cold-worked Copper. H. C. Kenny & G. L. Craig. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 196-204. Includes discussion. See *Metals & Alloys*, Vol. 5, July 1934, page MA 353. (11a)

Phosphor Bronze Castings—Their Production. F. Hudson. *Metallurgia*, Vol. 11, Feb. 1935, pages 95-99. In making P-bronze castings it is important to melt as rapidly as possible and in a slightly oxidizing atmosphere. H_2 and CO in the melting atmosphere produce unsound castings. Casting temperatures should be between 1020° and 1100° C. Poor castings have been attributed to impurities when they should have been attributed to improper melting or casting practice. JLG (11a)

Improvements of Al Alloys of Higher Cu Content by Mg Additions (Ueber die Verbesserungen von höher Cu-haltigen Legierungen durch Mg-Zusätze). H. Bohner. *Aluminium*, Vol. 17, Feb. 1935, pages 72-73. Studies of the possible improvements of Al-Cu-Mg alloys have given the following results: (1) The higher the quenching temperature, the higher, for the same thermal treatment, the tensile strength. (2) Tensile strength is also higher, the higher the tempering temperature for the same tempering time, or, the longer the tempering time for the same tempering temperature. (3) Additions of Mg to Al-Cu alloys of same mechanical and thermal treatment and of practically the same Fe, Si and Cu contents, increase tensile strength considerably. (4) The great reduction in elongation caused by Mg additions under 0.5% to Al-Cu alloys which have been tempered at 140° C. is avoided by additions of over 0.5% Mg. (5) Additions of Ti+Mn or of Mn to Al-Cu-Mg alloys improve tensile strength and increase elongation of the ternary Al-Cu-Mg alloys if the thermal treatment of the alloys is the same. (6) The elastic limit (0.2%) of the Al-Cu-Mn-Mg-Ti and of the Al-Cu-Mo-Mn alloys is below the respective tensile strengths by the following amounts: 12-14 kg./mm.² after natural hardening, 10-12 kg./mm.² after hardening at 120° C., 8-10 kg./mm.² after hardening at 140° C., 7-9 kg./mm.² after mixed-thermal hardening. Thus the ratio of elastic limit to tensile strength is much better in the alloys containing Mg. (7) If the hardened material with Cu contents of 6-7% is subjected to a further slight cold-working the elastic limit can be still further increased by about 1-2 kg./mm.² These results show better values for Al with Mg additions than for the Al alloys used so far. Ha (11a)

Spontaneous Hardening of Aluminum Alloys (Selbstveredlung von Aluminiumlegierungen). M. v. Schwarz. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, Sept. 28, 1934, pages 133-137. Self-hardening alloys are those which contain Zn or Cu; they require particular care in their production. Some of the raw materials and preliminary alloys used in their production are described. Storing at room temperature increases the elastic limit more than twice that of ordinary aluminum alloys, and they have a fairly good strength even at 100° C. The advantages obtained by their use in the construction of airplanes and other vehicles are pointed out; properties of several types of such alloys are tabulated. The elasticity modulus lies at about 8600 kg./mm.² whereby the permanent elongation is 0.001%. Ha (11a)

11b. Ferrous

E. S. DAVENPORT, SECTION EDITOR

Effect of Sulphur on Forging Steel. Report of the Joint Committee on Investigation of the Effect of Phosphorus and Sulfur in Steel. H. S. Rawdon, Chairman. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 87-112. The present report deals with simple carbon forging steels containing 0.45-0.55% C and from 0.02 to 0.12% S. Physical properties were determined and the effect of S summarized as follows. The curves summarizing tensile strength, proportional limit and yield point in tension, shearing stress at maximum torque and shearing stress at proportional limit in torsion, show a slight, though distinct, downward trend with increase in sulphur content; though slight or negligible for the annealed steels, and especially for the 1" rounds, the trend is unmistakable in the quenched-and-tempered steels. The downward trend in these properties is consistent with the corresponding trend in carbon content; the fact that after quenching and tempering the downward trend was intensified, confirms the effect of variation in carbon content. The curves summarizing ductility of the steel in tension (reduction of area and elongation) and the angle of twist at the proportional limit in torsion, show no marked or significant changes which may be associated with sulphur content. Likewise, the ability of the steel to withstand severe deformation as measured by angle of twist (at fracture) and Brinell hardness was not adversely affected by increased sulphur content within the limits employed. The curves summarizing impact resistance (Charpy test) of the various steels show the least consistent relationship of all the various properties with respect to sulphur content in both the annealed and the quenched-and-tempered condition. Many more data would be required before conclusions could be drawn concerning any general relationship. "In summarizing the data for the tests of all types, it may be stated of group III forging steels that the evidence, though less clear-cut than might be desired, shows no systematic relation between the increasing sulphur contents and the physical properties studied, and points to the conclusion that the physical effects of residual sulphur in this grade of steel are of such low magnitude that they are masked by other more potent variables." VVK (11b)

Effect of Added Phosphorus on Low-Carbon Steel. Report of the Joint Committee on Investigation of the Effect of Phosphorus and Sulfur in Steel. H. S. Rawdon, Chairman. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 113-121; discussion, pages 122-123. This investigation was carried out on tube material containing 0.10-0.12% C and from 0.007 to 0.080% P. The physical properties were determined in the as received, annealed, and quenched conditions and the effect of P was summarized as follows. The results of the tests have shown an increase in tensile strength and a decrease in percentage of elongation with increasing phosphorus content, whereas in the case of the proportional limit and reduction of area a characteristic relationship has not been established. The shearing strength was affected, by increased phosphorus content, similarly to the tensile strength. Within the limits of phosphorus content employed, an increase in phosphorus did not adversely affect the behavior of the steels under cold bending in the as-received or annealed conditions, but did have an adverse effect in the quenched condition. The effect of some extraneous factor of far greater importance than the phosphorus content is shown by results of impact tests; this factor is in some way associated with some apparent "abnormality" of one of the steels as shown by the microstructure. This factor, however, has not affected the tensile properties to any significant degree, nor has the behavior of the steels under cold bending or shearing been noticeably affected. There is a very satisfactory degree of uniformity between the tensile properties determined longitudinally (in the direction of rolling) and transversely to the direction of rolling. On the basis of the tensile, shear and bending properties, all of the materials, regardless of the phosphorus content, are apparently good steels. VVK (11b)

Alloys of Iron and Copper. J. L. Gregg & B. N. Daniloff. McGraw-Hill Book Company, New York, 1934. Cloth, 6 x 9¼ inches, 454 pages. Price $5.00.

This is the fourth volume in the Alloys of Iron Research program. The same high standard shown in the previous volumes has been maintained. Within recent years, copper has grown to a place of considerable importance in the steel industry and, unfortunately, the information required for its use has been lacking in many respects and widely scattered. The authors have carefully and critically assembled the information and the result is of great practical value. The inclusion of an author's summary at the end of each chapter, as was done with two other volumes of the series, is very much to be commended as it is difficult for the reader to judge of the quality of work reported without consulting original reports and the conclusions of the authors should receive major consideration. Considerably more attention is given to the very early work than seems to be justified since much of it has been displaced by later more accurate investigations. This is particularly true of the chapter on the iron-copper constitutional diagram. However a diagram is given that seems to represent the extent of our knowledge at the present time. A chapter on precipitation hardening of copper steels is included. A peculiar effect is noted. As the copper content is increased from 0.7% the hardening on reheating increases until the copper content is between 1 and 1.5%. On further increase in copper content the hardening effect decreases, an effect that will require further investigation before an adequate explanation can be offered. The mechanical properties of the iron-copper alloys and of the wrought copper steels are adequately treated. The chapter on corrosion is an excellent summary. The effect of copper in cast iron, in complex steels and other alloys and a discussion of the copper-rich alloys are treated in the final chapters. 399 references are referred to in the text. The book is to be recommended as an unbiased, concise review.

V. V. Kendall and F. N. Speller (11b)-B-

The Book of Stainless Steels. Edited by E. E. Thum. 2nd Edition. American Society for Metals, Cleveland, 1935. Cloth, 6¼ x 9¼ inches, 787 pages. Price $5.00.

The first edition appeared but 16 months before the second, the necessity for which, in so brief a time, is eloquent of the usefulness of the volume. While the bulk of the book is reprinted from the first edition, many chapters, including those on constiution, heat-treatment, are welding, sheet, plates, alloy modifications, stellite, scaling, uses in petroleum refining, automotive manufacture and marine service, as well as all the chapters on castings, have been revised. New chapters on thermocouple alloys, Illium, and railroad rolling stock have been added. This all makes the second edition over 150 pages larger than the first. The Chinese puzzle system of identification of composition of trademarked alloys used in the first edition has been replaced by a simple listing of compositions that is a real improvement.

Portrait plates of several pioneers in the stainless field add to the attractiveness of the volume.

It's a good thing that the binding is strong, for the book will be referred to very often. It is to be hoped that other editions will follow as fast as information accumulates. Ultimately a rewriting by one author rather than the presentation of chapters by many authors would be in order when the book gets much more bulky. At present one is likely to find information on a given topic in several different chapters. Footnote cross references and careful indexing make it possible to locate most of what one wants on a subject, but the continuity could be improved. For the present, the method used is the better since it brings out divergencies of opinion among the chapter authors.

Owners of this book will not care to lend it, they are liable to need it while it is gone. H. W. Gillett (11b)-B-

Alloy Steel and Ferro Alloys in 1934. James C. Vignos. *Blast Furnace & Steel Plant*, Vol. 23, Jan. 1935, pages 33-34; *Heat Treating & Forging*, Vol. 21, Jan. 1935, pages 19-20. Reviews developments. Production of alloy steels has increased due to their greater use in the automotive and transportation fields and to more intensive merchandising. Pearlitic alloy steels have been developed to meet requirements too severe for plain C steels, and where high Cr-Ni alloys are too expensive. Steels containing 2.50-3.00% Ni and 0.30-0.70% Cr or Mo have been developed for resistance to impact at low temperatures. X-ray investigation is proving to be of value in the study of alloy systems. Alloy contamination of steels is receiving increasing attention. Intelligent use of ferro-alloys for deoxidation still remains the chief problem in steel production as a whole, and has received much consideration. It is hoped that the amount of Al necessary for final deoxidation can be greatly reduced by a better understanding of the use of ferro-Mn and ferro-Si under controlled conditions. MS (11b)

Inductance of Steel Reenforced Aluminum Cable. L. F. Woodruff. *Electrical Engineering*, Vol. 54, Mar. 1935, pages 296-299. Tabulated calculated values of inductance of steel reenforced Al cable indicate that previously published values are in error by amounts ranging up to 5%, always on the low side. The inductance is affected by: (1) the stranding of Al, (2) the spiraling of Al strands, (3) by skin effect, (4) by proximity effect, and (5) by effect of the steel core. 9 references. WHB (11b)

Magnetic Anisotropy in Silicon Steel. K. J. Sixtus. *Physics*, Vol. 6, Mar. 1935, pages 105-111. The magnetic non-uniformity of 3.5% Si steel used in transformers and rotating electrical machinery was investigated. Preferred orientation of crystals persists even after final, high temperature anneal; thus directions of easiest magnetization of the material are present. The material is compared with single crystals, which have anisotropic magnetic properties. Hot rolling and cold rolling produce entirely different effects on the material when finally annealed, insofar as direction of preferred orientation is concerned. Data were obtained by means of electrical torque measurements and light reflection methods. WB (11b)

Dependence of the Beginning of Flow on Stress Distribution and Material (Ueber die Abhängigkeit des Fliessbeginns von Spannungsverteilung und Werkstoff). E. Siebel & H. F. Vieregge. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 21, 1934, pages 225-239. Tensile, bending and torsion tests, and application of external pressure with different steels confirmed that the upper flow limit is increased by irregular stress distribution, and this the more, the more the local stress peaks exceed the average stress. This is much more pronounced in soft steel than in hard steel. Structural parts should be so dimensioned that the load in the highest stressed section remains sufficiently below that at which the fully plastic state is reached. The results are illustrated by curves and diagrams. Ha (11b)

High Chromium Cast Irons. GARNET P. PHILLIPS. *Transactions American Foundrymen's Association*, Vol. 6, Feb. 1935, pages 279-288. Cr is used in many alloys for heat and corrosion resistance and this paper describes methods of manufacture of high Cr irons containing approximately 20 to 35%. These irons were made in the electric furnace. They may be divided into 2 classes, one containing 1% C or less, and the other containing more than 1% C. Melting, molding, and pouring procedure are outlined. The author had used ferro-chromium containing 0.7-0.8% N with great success in producing fine-grained, low-C alloys having good physical properties. The physical properties of typical irons and their microstructures in various states are shown. The author also mentions: reasons for failures, thermal expansion, design, heat treatment, properties at elevated temperatures, heat and corrosion resistance and applications. CMS (11b)

1

Permanent Set and Elastic Hysteresis in Cast Iron. J. E. HURST. *Foundry Trade Journal*, Vol. 51, Dec. 27, 1934, pages 405, 406; Vol. 52, Jan. 17, 1935, pages 63-66. Experimental investigations have been made using annular ring-form specimens. A series of test-rings were machined from a sand-cast, annealed motor-car engine cylinder barrel, an "as-cast" motor-car engine cylinder barrel and a centrifugal casting of drum form. The gap was cut and rings were subjected to compressive and tensile stresses. Permanent set, influence of time on gap dimensions, hysteresis due to strain, elastic hysteresis, internal stress, etc. are discussed. The experiments demonstrate that the gap dimensions in the test-rings which were subjected to stressing by opening or closing, undergo a change with time after the removal of the applied stress, and a stable gap measurement is obtained only after several hours after the removal of the stress. This is the phenomenon referred to as "hysteresis" due to strain. The magnitude of the hysteresis was greater in the sand castings, than in the centrifugal castings, and greater in the stabilized than in the "as-cast" specimen. AIK (11b)

2

Hardenable Copper-Alloyed Cast Steel (Aushärtbarer kupferlegierter Stahlguss). E. SÖHNCHEN & E. PIWOWARSKY. *Giesserei*, Vol. 28, Mar. 1, 1935, pages 96-100. Cu steels belong to the class of alloys which harden by precipitation as the solubility of Cu in α-Fe decreases with decreasing temperatures. Experiments with an electrically melted and a Bessemer steel showed that precipitation hardening takes place between 400° and 600° C. with a maximum hardness at 500° C. The effect of C, Ni, Cr, Mo, V, Mn and Si on the Cu precipitation is discussed and the work of other investigators reviewed. Ni, Cr, Mo and V have an accelerating effect on the hardening of 1% Cu steel. Annealing increases the strength of Cu steels, 200° C. giving a maximum. Addition of Cu increases magnetic coercive force, and improves resistance to corrosion. Ni prevents red-brittleness in Cu steels as it forms solid solutions of higher melting point with the precipitated Cu. As precipitation hardening of Cu steels can be obtained with very low C content these steels can be forged readily. 15 references. Ha (11b)

3

Specific Heat of Iron Carbide (Die spezifische Wärme des Eisenkarbides Fe_3C). G. NAESER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 16, No. 19, 1934, pages 207-210. Heat contents of pure, crystalline Fe_3C were measured between —190° and +770° C. and average and true specific heats calculated; the values are given in a table. The rule of additivity of atomic heats does not hold good for cementite. The heat of reaction of the magnetic transformation is about 1.5 cal./g. 18 references. Ha (11b)

4

Electrical-Heating, Electrical-Resistance, and Electric-Furnace Alloys Report of A. S. T. M. Committee B-4. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 244-248. Progress report. VVK (11b)

5

The Engineering Properties of Cast Iron. A. B. EVEREST. *Foundry Trade Journal*, London, Vol. 51, Dec. 20, 1934, pages 385-386, 398. Extract of a lecture given before the Wales, Monmouth and West of England branch of the Institute of British Foundrymen, on November 17, 1934. The author deals with cast iron, principally from the engineer's point of view. Structural control, machine tool castings, the influence of alloy additions, etc. are discussed. AIK (11b)

6

Effect of Precipitation in a Solid Solution on Mechanical and Chemical Properties (Relation entre l' Hétérogénéité d'une Solution Solide et ses Propriétés Méchaniques et Chimiques). PIERRE CHEVENARD. *Comptes Rendus*, Vol. 199, Oct. 29, 1934, pages 861-863. An austenitic alloy (Cr 10%, Ni 37%, C 0.3%, balance Fe) was quenched and reheated to allow precipitation in the solid solution. Curves were drawn to show the effect of precipitation on the elastic limit, internal resistance, hardness and corrosion resistance of the alloy. FHC (11b)

7

Effect of Shape, Surface Quality and Material on Durability of Cast and Welded Structures (Einfluss von Form, Oberflächenbeschaffenheit und Werkstoff auf die Dauerhaltbarkeit gegossener und geschweisster Konstructionen). A. THUM & F. MEYERCORDT. *Giesserei*, Vol. 28, Mar. 1, 1935, pages 90-94. The durability and strength of both cast and welded parts can be increased by giving them a shape which avoids sharp changes in stresses. Notched steel parts can be strengthened by reducing the stresses due to exterior load by superimposing interior stresses by plastic deformation at those places where the highest load is to be expected. Thin-walled castings are greatly strengthened by removing the casting skin which removes notch effects exerted by the graphite veins. Cr and Ni do not essentially influence the durability, a fine grain is of much greater importance. The experiments show that, in general, it is easier to take advantage of the high strength of the material, also under alternating stresses, in cast Fe than it is in a welded steel or cast steel structure. This is particularly the case for thin-walled cast Fe. Ha (11b)

8

Heat Resisting Cast Iron (Progrès dans la Fabrication des Fontes Réfractaires). AUGUSTE LE THOMAS & RENÉE LE ROMANCER. *La Fonte*, No. 14, 1934, pages 542-548. Cast iron with C 2.7-3.2%, Si 1.1-1.2%, Mn 0.7-1.0%, S 0.06-0.10%, P 0.08-0.15% was used to give heat resistant castings. Details for mixing and casting are given. WHS (11b)

9

Steel-making Alloys. W. F. ROWDEN. *Metallurgia*, Vol. 11, Jan. 1935, pages 67-72. Alloying elements used in steels are listed together with the forms in which they are added to steels. The influence of each element is briefly discussed. Properties of some special steels are given. Manufacture of a steel heat is described. JLG (11b)

10

Investigation of the Composition of Common Cast Iron for Boilers. G. SIROVICH & G. VANZETTI. *Transactions American Foundrymen's Association*, Vol. 5, Dec. 1934, pages 71-93. Exchange paper presented on behalf of the Italian Foundry Association. The authors have investigated the possibility of using a cheap mixture for cast iron boilers. Their problem was complicated by the fact that in Italy, only low-C, high-P, low-Si pig iron is available at moderate prices. They tested a number of different mixtures, keeping close control of the chemical composition. Test bars from the different irons were subjected to transverse, deflection, and impact tests. Since boilers are likely to have sudden temperature changes, the coefficient of thermal expansion of the various irons was determined, but was found to be practically the same in every case. Authors found that the limitations on P content which appear in some specifications are not justified, unless they are given in relation to the other elements. They also conclude from their work that a low-C, high-Si, high-P iron is not only cheap to make, but also is superior in physical properties to a low-P iron. The high Si in such irons is obtained by the use of ferrosilicon additions, as this is more economical than buying a high-Si pig iron. CEJ (11b)

1

Plastic Strain and Creep Stress. R. W. BAILEY. *Iron & Coal Trades Review*, Vol. 130, Feb. 22, 1935, page 331. Relation between proportional limit and beginning of creep as marked by a change in slope of stress-strain line is explained and it is pointed out that this is important for inspecting materials but of little practical importance when determining working stress under creep conditions. The change of creep by prolonged heating due to change in the microstructure, additions of elements to steel which increase the creep strength (e.g. Mo), and means to minimize distortion of parts or structures in service are discussed. Ha (11b)

2

What Demands Can We Make of Corrosion and Heat Resistant Irons and Steels? (Welche Anförderungen können wir derzeit an korrosions- und hitzebeständige Eisen- und Stahlsorten stellen?) A. LISSNER. *Montanistische Rundschau*, Vol. 27, Mar. 16, 1935, pages 1-7. In selecting a material for use under corrosive conditions the following properties should be considered: composition, physical characteristics, workability hot and cold, welding properties, and heat treatment. The many alloys used in this field may be arranged in the following main groups: ferritic and semi-ferritic Cr-steels; martensitic Cr-steels; austenitic Cr-Ni steels, often containing Cu, Mo, W, etc.; alloys low in Fe and high in Ni, Cr, Co, etc.; Si-irons, and austenitic cast irons. Heat resistance is obtained by the use of such alloying elements as Cr, Al, Si, Ti, Co, W, and others; Ni should be avoided where sulphurous gases are present. In addition to high heat resistance the alloys should also possess resistance to rapid changes in temperature; they should not be susceptible to heat or precipitation hardening, for which reason martensitic steels are generally excluded from this group. They should possess a creep resistance of 8-12 kg./mm.^{2} at 600° C., and should also have a high resistance to wear at elevated temperature. Special electric and magnetic properties are frequently called for. Numerous industrial applications of heat and corrosion resistant steels are given. BHS (11b)

3

Improved Properties Extend Uses for Gray Cast Iron. W. WORLEY KERLIN. *Steel*, Vol. 95, Aug. 13, 1934, pages 42-44. Same as *Foundry*, Vol. 62, July 1934, pages 23, 52. See "Properties Extend Gray Iron Uses," *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 120. MS (11b)

4

The Properties of Non-Hardenable Alpha-Iron Steels. S. H. REES. *Iron & Steel Industry*, Vol. 8, Oct. 1934, page 22. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 582. CEJ (11b)

5

Quality Standards for Wrought Iron. Report of A. S. T. M. Special Subcommittee X on Research. JAMES ASTON, CHAIRMAN. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 129-144. A review of the physical, chemical and structural characteristics of wrought iron. 15 illustrations. VVK (11b)

6

The Fracture Test as Used for Tool Steel in Sweden. RAGNAR ARPI. *Metallurgia*, Vol. 11, Mar. 1935, pages 123-127. The test is made by quenching sample bars at different temperatures, fracturing, and comparing the fractures of the untempered material with standard fractures. Penetration of hardness is also observed. Results are given which show that coarseness of fracture depends on factors other than composition, e.g. melting method and deoxidation practice. The influence of oxygen and non-metallic inclusions on grain size and fracture coarseness is discussed. 30 references. JLG (11b)

7

Alloys of Iron Research Committee. C. H. DESCH. *Institution of Mechanical Engineers, Proceedings*, Vol. 127, Apr.-Nov. 1934, pages 277-298; *Foundry Trade Journal*, Vol. 51, July 19, 1934, page 48. Work done at the National Physical Laboratory comprising determination of equilibrium diagrams by microscopical, thermal and X-ray methods. The alloys of Fe with Si, O, P, Cr and Mn were studied. These alloys of high melting point sometimes require the development of new refractories, which, in turn, have some bearing on improvements in steel manufacture. Report of the Committee is given in full with discussion. Ha+CEJ (11b)

8

Cast Iron. Report of A. S. T. M. Committee A-3. HYMAN BORNSTEIN, CHAIRMAN. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. I, 1934, pages 145-147. Progress report. **Report of Special Subcommittee on Test Bars.** R. S. MACPHERRAN, CHAIRMAN. Pages 148-153. This committee was appointed to secure information on methods of making test bars, correlation of test bar sizes and controlling sections, determination of deflection values in the transverse tests and comparison of tensile strength tests on broken halves of transverse test bars and on separately cast tension bars. Tests were made at the University of Illinois, Allis-Chalmers Manufacturing Co., University of Michigan and the University of Wisconsin. Part of the work is reported in the form of tables but no recommendations are made as the program is still incomplete. In the tests at the Allis-Chalmers Mfg. Co., good results were obtained on tension test bars prepared from the transverse bars as compared with the separately cast tension bars; the same held true for the tests at the University of Michigan. VVK (11b)

9

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12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Influence of Iron, Aluminium, and Silicon Upon the Impact Value of Brasses at Higher Temperatures. MASAICHI NISHIKAWA & EIICHI ITO. *Suiyokwai-shi*, Vol. 8, Oct. 1934, pages 625-629. Brasses containing 62-65% Cu and small proportions of Fe, Al and Si, less than 1%, were prepared and their impact values at higher temperatures measured with a Charpy machine. Iron did not have a great influence upon the impact values of brasses containing 62-65% Cu. Such alloys had their max. impact values at 750°-850° C. depending on the content of Cu. Al and Si, however, had a great effect on the impact value and the temperatures at which the max. impact value occurred were lowered to 500°-700° C. and 450°-650° C., respectively, in the brasses containing Al and Si. HN (12)

Tensile Strength of Steel at Low Temperatures. G. GRUSCHKA. *Foundry Trade Journal*, Vol. 51, Sept. 6, 1934, page 148. Abstract of paper appearing in *Forschungsheft* 364, supplement to *Forschung auf dem Gebiete des Ingenieurwesens*. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 494. CMS (12)

The Influence of Silicon and Aluminum on the Resistance of Cast Iron to High Temperatures. M. H. THYSSEN. *Iron & Steel Industry*, Vol. 8, Oct. 1934, page 23. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 584. CMS (12)

Comparative Studies on Creep of Metals Using a Modified Rohn Test. C. R. AUSTIN & J. R. GIER. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 53-74. Includes discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 290. (12)

Factors Influencing Creep. R. W. CARSON. *American Machinist*, Vol. 79, Mar. 27, 1935, pages 261-263. Creep effects as manifested at elevated temperatures occur also at ordinary temperatures though to a much lesser degree. For instance, a bolt tightening together 2 flanges applies an initial stress which, in time, becomes less, the bolt "relaxes." The creep phenomenon at low temperature is closely related to the high temperature creep, and while at the high temperature creep is only in one direction, at lower temperature creep in the reverse direction sets in after removal of the load. In general, high working stresses or high stress concentrations are sources of creep effects. Age hardening alloys have a high resistance to creep as e.g. Be-Cu, heat-treatable Cu alloys and Ni steel and Ni-Be. Ha (12)

Behavior of Metals at Elevated Temperatures. H. DUSTIN. *Iron & Steel Industry*, Vol. 8, Oct. 1934, page 24. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See "Belgian Research Committee on the Behaviour of Metals at Elevated Temperatures," *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 584. CEJ (12)

The Effect of Elevated Temperatures on the Strength and Dimensional Stability of Certain Aluminum Alloys Used in Aircraft. RICHARD R. KENNEDY. *Transactions American Foundrymen's Association*, Vol. 5, Dec. 1934, pages 48-70. Engine parts such as cylinder heads and pistons, which are exposed to elevated temperatures in service, suffer a loss in strength at operating temperatures and may be annealed partially so that the strength of the parts is impaired permanently even after cooling to room temperature. Also some Al-alloys are subject to permanent growth when exposed to elevated temperatures. The investigation was conducted to determine the casting shrinkage of four Al-alloys used in aircraft, and the effect of heat treatment and of exposure to temperatures in the operating range (350°-550° F.) on the strength and dimensional stability of these alloys. The Cu-Ni-Mg alloys in the heat treated condition were least affected. The 4% Cu- 0.7% Si alloy showed considerable permanent growth after reheating. The 5% Si- 1.25% Cu alloy had the lowest tensile strength and hardness of the alloys investigated. CEJ (12)

The Ductility of Chromium-Nickel Austenitic Steels at Elevated Temperatures. H. D. NEWELL. *Transactions American Society for Metals*, Vol. 23, Mar. 1935, pages 225-248. Paper read and discussed at A.S.M. Convention, 1934. Previously abstracted from Preprint 25. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 538. WLC (12)

Oxidation of a Low Carbon Steel in the Temperature Range 1650 to 2100 Degrees Fahr. CLARENCE A. SIEBERT & CLAIR UPTHEGROVE. *Transactions American Society for Metals*, Vol. 23, Mar. 1935, pages 187-224. Paper read and discussed at A.S.M. Convention, 1934. Previously abstracted from Preprint 3, 1934. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 538. WLC (12)

Effect of Testing Temperature on the Specific Impact Work of Cast Iron (Der Einfluss der Prüftemperatur auf die spezifische Schlagarbeit von Gusseisen). E. VON RAJAKOVICS. *Giesserei*, Vol. 28, Mar. 1, 1935, pages 95-96. Experiments with several kinds of cast Fe have shown that the temperature at which bending-impact tests are made can exert a great influence even in the range of ordinary room temperatures. In general, the specific impact energy increased from —20° to about 100°-200° C. and then began gradually to decrease again up to 580° C. (maximum testing temperature). Ha (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

Deterioration of Structures of Timber, Metal and Concrete Exposed to the Action of Sea Water. *14th (interim) Report of the Committee of the Institution of Civil Engineers,* for the year ended Mar. 31st, 1933, pages 1-8, **The Final Examination of the Second Series of Iron and Steel Specimens Exposed at Plymouth for 10 years.** J. NEWTON FRIEND. Pages 8-27, **The Final Examination of the Second Series of Iron and Steel Specimens Exposed at Colombo for 10 years.** J. NEWTON FRIEND. Pages 27-40. The committee report is a summary of the results of the various tests of timber, metal and concrete. The Plymouth report shows that bars of iron and steel exposed to sea air at Plymouth corroded on the average, twice the amount during the 10 years as for the 5 year specimens. Several of the alloy steels lost less weight in the test of longer duration. Bars with mill scale corroded to a greater extent than similar bars ground free from the scale but the difference between the two was less pronounced after 10 years than after 5. Best results were obtained with Ni steels and cast-irons. Cu steels were less corroded than mild steels while Cr steels showed tendency to pit. In the alternate wet and dry tests at half-tide level the Ni, Cr steels and cast-irons were more severely corroded. The relative corrosion of the bars was similar to the order of results for the 5 year test. For Cu steels the .6% Cu was superior to the 2.0% Cu steel which is the reverse of the results from the 5 year test. The bars cleaned free of scale lost more weight than as rolled bars but were not as deeply pitted. The 36% Ni steel gave best results, being free from pitting. Cr irons showed some pitting of serious character and cast-irons showed deep penetration of corrosion to interior although little weight was lost. In the tests of totally immersed specimens the cast and wrought irons, the mild and medium C steels and the Cu steels corroded about the same as in the intermittent wet and dry exposure. Ni and Cr steels lost more weight during continuous submersion than in intermittent tests. Cr steel again was deeply pitted. Cast-irons were badly attacked at edges and below the surface. The 36% Ni steel corroded to some extent but showed by far the best corrosion resistance. A fresh water test showed the same wormy corrosion effect as was characteristic of the specimens in the similar 5 year test. Corrosion of the descaled bars compared with the as rolled showed the latter to be less uniformly corroded. Cu steels were less corroded than mild steels but had deeper pits. Ni and Cr steels were fairly resistant but the cast-irons were pitted and graphitized. Another series of tests are reported in which the effect of cold work by exposure of bars bent cold, on the nature and extent of corrosion was determined. No marked corrosion difference between the different areas was noted except in the case of the high Ni steel continuously immersed in sea water. In this case a few pits showed up in the cold worked region at the outer edge of the bend. In the tests of exposure for 10 years to sea air at Colombo the bars showed greater loss than other sets exposed either at Colombo or other stations. A thick crust of rust was formed on all specimens. No internal corrosion of the cast-iron occurred. The Swedish and Low Moor irons showed better corrosion resistance than the cleaned steels and the latter iron corroded to a smaller extent than any of the C steels, Cu and 3.5% Ni steels. The 36% Ni again showed least corrosion while the Cr steel showed deep cavities as before. In the intermittent tests at half-tide level at Colombo the high Ni and Cr steels were not coated as thickly with a crust of marine growth as the other bars and consequently were not protected to the same degree. They were found to have corroded to an extent respectively 10 and 4 times greater than the corresponding bars exposed to sea air. Graphitization of the cast irons accounted for their almost complete disintegration. C steels showed in general less resistance than wrought iron. Cu steel showed no lower corrosion and the low Ni bars corroded to considerable extent. 36% Ni steel was badly attacked in certain areas but on the average showed best resistance. Cr steel was severely corroded locally. For total immersion at Colombo wrought iron again had the advantage over C steels. The descaled specimens were more uniformly corroded than as rolled. Cu steels showed smaller weight loss but more pitting. Cr steel showed erratic results in that it was less seriously pitted than was expected by comparison with other Cr steel results. Photographs are shown of the bars with part of the crust of corrosion products removed. The crust is many times thicker than the bar itself. The appearance of the bare metal after cleaning can be seen in the series of photos, also the depth of penetration of the cast irons from photos of fractured specimens. WB (13)

Study of Non-Corrosive Steels for Soy-Bean Souse. HARUJIRO SEKIGUCHI. *Kinzoku no Kenkyu,* Vol. 12, Jan. 1935, pages 67-78. In Japanese. A series of corrosion tests have been carried out for the purpose of finding non-corrosive steels for soy-bean souse. Cylindrical steel specimens containing different amounts of a special element such as Cr, Co, Ni, W, Mo, Cu and Mn, have been immersed in soy-bean souse, and after elapse of a definite time weight losses of specimens have been measured. The corrosion losses are found very small on the steels containing 7% Cr or more, and the soy-bean souse in which these steel specimens have been immersed retained the original taste and odor of sweetness for a considerable period of time. Accordingly, economical, non-corrosive and suitable steels for soy-bean souse are those containing from 7 to 8% Cr. The steels which contain a moderate quantity of Ni are also non-corrosive and can be used as well, but these are less effective and more expensive than Cr steels. KT (13)

Corrosion of Iron and Steel, Report of A. S. T. M. Committee A-5. *Proceedings American Society for Testing Materials,* Vol. 34 Pt. I, 1934, pages 154-185. Progress reports of Sub-Committees. Further failures in the atmospheric test at Annapolis (Sub-Committee III) and the total immersion tests (Sub-Committee V) are noted. Sub-Committee VIII on Field Tests of Metallic Coatings give some data additional to the extensive tabulation of 1933. A wire test program has been organized (specifications in Appendix pages 172-183) which will include farm-field fencing, plain wire, barbed wire, wire strand and chain-link fence of the following kinds of materials: uncoated wire and fencing, (both copper-bearing and non-copper-bearing), galvanized (any galvanizing process permitted), stainless steel, copper-weld, lead-clad, and dichromate-treated wire (unfabricated). The latter process has recently been developed to improve the servicability of galvanized coatings which are not bent in service. VVK (13)

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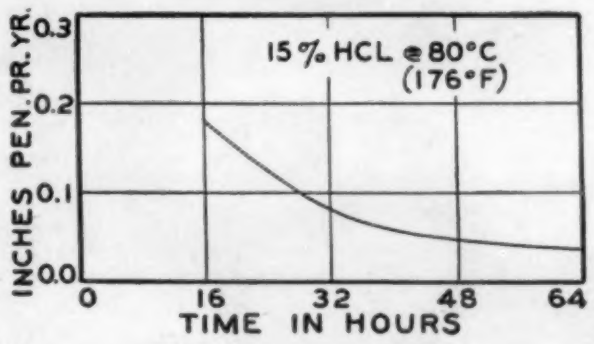
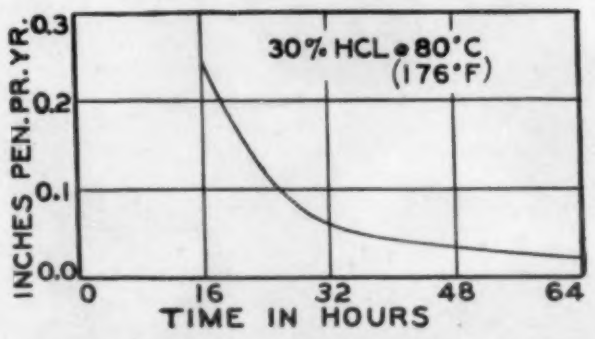
These curves illustrate the corrosion-time rates for completely ground surfaces. Relative flatness indicates speed at which stable surface films are built up in a comparatively short time. Thin films of this type are especially resistant to the triple action of stress, corrosion and erosion.





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A. P. I. Pipe-Coating Tests. Progress Report No. IV—Third Inspection of Pipe-Coating Tests on Operating Lines and Second Inspection of Short Coated Specimens. GORDON N. SCOTT. *Proceedings American Petroleum Institute, Division of Production*, Vol. 15 (IV), 1934, pages 18-37. The results of the third inspection of the coatings on operating lines and second inspection of coatings on short pipe sections are presented. While complete prevention of corrosion by any of the coatings in these tests has not been realized, pitting has been reduced by most of the coatings. A practical view of the problem of pipe protection is taken, and suggestions offered in the choice of coating. Shielding or reinforcing is considered minimum and necessary practice in pipe protection for average conditions. Special measures depending upon circumstances will be required in severely-corrosive environments. In general, soil stress is progressive, and is the most important factor in coating design. Resistance against soil stress must be provided through the use of inert fillers, by increasing the melting point of the bitumen, by increasing the thickness of the coating, or by shielding and reinforcing. The next most important progressive factor is the absorption of moisture by the coating. A reinforced coating may be made more impervious to moisture by an increase in thickness through the more abundant use of bitumen, by the use of less absorbent or less easily rotted fabrics. Neither of the electrical tests is entirely satisfactory for arranging all coatings in any order or preference. In a particular case the conductance may measure the amount of water absorbed and/or the area of pipe surface exposed. The amount of dissolved substance in the water will determine the particular value of conductance determined. The pattern test is efficient only when there is an actual exposed area of pipe. However, both of these tests are of value in eliminating the less desirable coatings. The best criterion for judging the behavior of a coating is the condition of the pipe. For the purpose of arranging a variety of coatings of different types in order of relative merit, tests on short pipe sections of small diameter do not agree closely with tests on large operating lines. Reasons for this disagreement are discussed. Within a group of similar coatings the order of relative merit obtained on short pipe sections is reasonably accurate. 5 references. VVK (13)

Corrosion of Dairy Utensils in Sour Skimmed Milk, Semi-solid Sour Milk, Sour Whey and Thickened Sour Whey (Untersuchungen über die Korrosion an milchwirtschaftlich wichtigen Werkstoffen in Sauerer Magermilch, halbfester Sauermilch, sauerer Molke und eingedichten saueren Molken). W. MOHR, R. KRAMER & W. SCHRÖTER. *Molkerei-Zeitung* (Hildesheim), Vol. 48, May 11, 1934, pages 1054-1056. Corrosive action of several milk products of varying acidities, on numerous metals and compounds was tested. Results were indicated by loss in wt. and by appearance of corroded surfaces. The metals tested were (1) iron, (2) V2A steel, (3) V2A welded steel, (4) tinned Fe, (5) half-tinned Fe, (6) Ni, (7) German silver, 8) unwrought Cu, (9) polished Cu, (10) bronze, (11), red brass, (12) brass, (13) soldered Cu, (14) tinned Cu, (15) spray-tinned Cu, (16) half-tinned Cu, (17) tinned and soldered Cu, (18) Pb, (19) Zn, (20) 99.5% Al, (21) 99% Al, (22) refined Duralumin, (23) Anticorodal B and (24) enamelled steel. The dairy products studied were: (a) skimmed milk, 38-40° S.-H., 19-20° C., 48 hours (S.-H., Soxhlet-Henkel, refers to degrees titratable acidity); (b) soured skimmed milk, 38-40° S.-H., 19-20° C., 48 hours; (c) strongly soured skim milk, 72-90° S.-H., 40-42° C., 24 hours; (d) strongly soured skimmed milk, 80-90° S.-H., 60 and 75° C., stirred 3 hours; (e) semi-solid sour buttermilk and a special sour protein product, 260° S.-H., 60 and 75° C., stirred 3 hours; (f) semi-solid sour buttermilk and sour protein, 260° S.-H., 19-20° C., 48 hours; (g) sour rennet whey, 60° S.-H., 60 and 75° C., stirred 3 hours; (h) thickened sour whey without added chalk, 330° S.-H., and with chalk, 140° S.-H., 60 and 75° C., stirred 3 hours, and (i) thickened sour whey without chalk, 330° S.-H., and with chalk, 140° S.-H., 19-20° C., 24 hours. Metals (2) and (3) were fully resistant to all products; (19) and (1) were least resistant. Products (a) and (b) were least corrosive; (h) and (e) were most corrosive. Metals (3) to (17) inclusive were fairly resistant to products (a), (b), (c), (f) and (i). (18) was resistant to (a). (19) to (23) inclusive were strongly attacked or corroded by all products except (a) and (b). (24) was resistant to (a), (b) and (i). Chalk added to the acid milk product protected the corrosive metals only partially. Decomposition was increased at high temperatures and high acidities. GPS (13)

The Fight Against Corrosion (La Lutte contre la Corrosion). JACQUET & GUERILLOT. *Usine*, Vol. 44, Mar. 7, 1935, pages 31-34. The different methods of protecting metals from corrosion by plating, enamelling or painting are discussed for sea air, city and rural atmospheric conditions. The minimum thicknesses required for a protection of 12-18 months are given as follows:

Nature of deposit	sea air		city atmosphere		rural atmosphere	
	Thickness in mm.	Wt. in mg./dm.²	Thickness in mm.	Wt. in mg./dm.²	Thickness in. mm.	Wt. in mg./dm.²
Ni	0.025	2500	0.05	5000	0.025	2500
Cr on 0.025 mm. Ni	0.00075	60	0.0024	200	0.0005	40
Zn	0.005	400	0.012	800	0.005	400
Cd	0.005	450	0.025	2000	0.005	450

Ni must have a thickness of at least 0.01 mm. to give effective protection. The best Zn deposits are obtained in cyanide baths but even then Zn corrodes with formation of "white rust" due to Zn salts formed by rain water. Cd deposits must have at least a thickness equivalent to 600 mg./dm.² to be equal to Zn deposits of same thickness. Cr alone does not protect at all. It is always deposited on Ni, or still better, first Cu, then Ni, on which Cr is plated. Hot galvanizing with Zn, Sn or Pb, rolling on of Al, cementing, nitriding and calorization processes, spraying, phosphating of the surface and oxidizing processes are briefly treated. Ha (13)

The Effect of Five Years' Atmospheric Exposure on the Breaking Load and the Electrical Resistance of Non-ferrous Wires. J. C. HUDSON. *Journal Institute of Metals*, Vol. 56, Dec. 1934, Advance Copy No. 690, pages 537-547. The corrosion of non-ferrous wires exposed in an industrial atmosphere for 5 years was measured by loss in strength and increase in electric resistance. Results of the 2 series of tests are in agreement with each other and with the results of earlier tests. In general, the rate of corrosion was small, that of Cu being of the order of 0.0002 in. per year. The rate was definitely higher for Ni, Ni-Cu alloys with high Ni, Zn, and brass, the breaking load of the latter alloy being appreciably impaired by copper redeposition. The most corroded material of all was galvanized iron, which corroded rapidly after the Zn coating had failed. For most alloys the rate of corrosion decreased with time. JLG (13)

Protection of Floating Roof of Oil Tanks. R. A. AXLINE. *Metallizer*, Vol. 8, Nov. 30, 1934, pages 2, 12. Tentative tests made on the practicability of protecting floating roofs of oil and gasoline storage tanks by the metallizing process indicate Zn and Cd to be definitely unsuitable, even with heavy coatings, Al to have possibilities, especially by using a fairly heavy coating, and Pb to be definitely protective. A heavy Pb coating of at least 0.020" is required. BWG (13)

Treatment of Water to Prevent Corrosion. JOHN R. BAYLIS. *Journal American Water Works Association*, Vol. 27, Feb. 1935, pages 220-234. It is pointed out that tests made about 10 years ago showed that no iron goes into solution when freshly cut iron lathe turnings are immersed in water saturated with $CaCO_3$ and access of air prevented. When considerable $CaHCO_3$ was present in the water and unsaturated with respect to $CaCO_3$, due to considerable CO_2 being present, the iron was corroded. The corrosion reduced the amount of CO_2 and in time the water became saturated with respect to $CaCO_3$ and corrosion ceased with no Fe present in the water. The saturation of water with $CaCO_3$ is suggested for preventing corrosion in water-carrying pipe but careful control is needed to prevent building up coating so thick as to reduce carrying capacity appreciably. Lime is cheapest material for preventing corrosion when $CaCO_3$ content is very low (less than 30 p.p.m.) WB (13)

Recent Work on Protection of Light Alloys (Travaux Récents sur la Protection des Alliages Légers). G. CHAUDRON. *Science et Industrie (Metaux et Machines)*, Vol. 19, Jan. 1935, pages 18-20. After a review of means which are available for protecting metals it is said that one type of protection only will be dealt with in the article, i.e. homogeneization process and addition of elements which, during corrosion, produce protective coatings. It is possible to get good corrosion resistance by building an Al_2O_3 coating by electrolysis in dilute H_2SO_4, part to be protected being the anode. The process can be applied to alloys consisting of homogeneous solid solutions. For heterogeneous alloys protective coating must be thick to be effective and the process becomes expensive. Chief kind of self-protected alloys are of the following types: Anticorrodal (Switzerland), Birmabright (England), Alumag KSS, BSS, etc. (Germany), Alumag (France) which contain Mg 0.7-11, Mn 0.5-1.4. In those alloys, some additions (Mn, Zn, Mo, Cd) are beneficial whereas some others (Cu, Fe, Si) are harmful. FR (13)

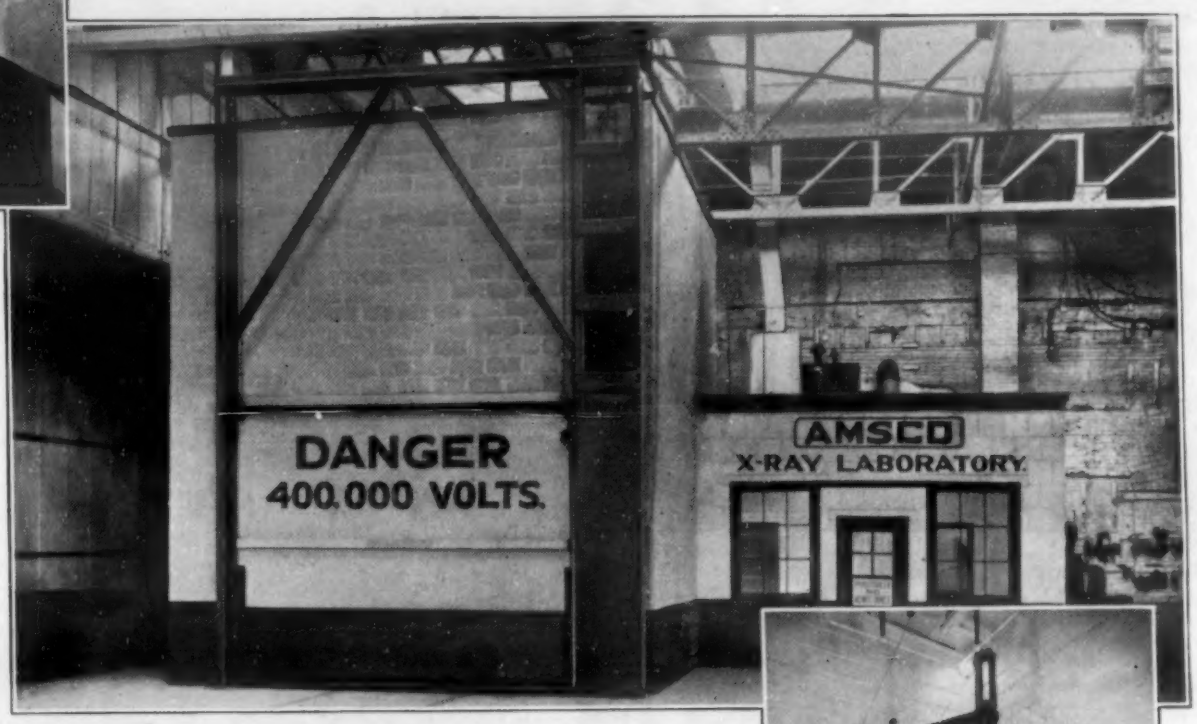
Inhibiting the Corrosion Velocity of Aluminum in Hydrochloric Acid by Means of Beta Naphthochinolin. (Zur Hemmung der Auflösungsgeschwindigkeit des Aluminums in Salzsäure durch Beta Naphthochinolin). ERNST JENCKEL & ERWIN BRAÜCKER. *Zeitschift für anorganische und allgemeine Chemie*, Vol. 221, Jan. 16, 1935, pages 249-276. The effect of the inhibitor was determined and an attempt made to relate inhibitor concentration to the change in potential, hydrogen overvoltage and corrosion velocity. Corrosion of Al was tested in various acids but principally in HCl at various concentrations, temperatures and inhibitor content. Reaction velocity constants were determined and conclusion made that the inhibitor's action is explainable only on the basis that it is a poison since the slight effect on the potential and hydrogen overvoltage could not account for the marked reduction in the corrosion velocity. The effect of stirring velocity on corrosion of Al in contact with the solution was found to be very slight. The hydrogen overvoltage in HCl solution was shown by means of curves showing variation in current density with time at various, constant potential differences at which the Al cathode was polarized. A number of Cu depositing tests were made on Al sheets and showed only spongy deposit when inhibitor was absent, but with inhibitor the Cu deposited very slowly in dense, adherent form. This is ascribed to formation of Cu-poison complex which is plated out at Al surface at a very slow rate. WB (13)

Intercrystalline Problems of Steels (Quelques problèmes de corrosion intercrystalline dans le domaine des aciers). EDWARD HOUDREMONT & PAUL SCHAFMEISTER. *Aciers Spéciaux, Métaux et Alliages*, Vol. 9, Sept. 1934, pages 258-268. In the 18:8 steels the maximum intercrystalline corrosion can be detected in material heated at 700° C. and increases with the length of time held at this temperature. Microscopic examination revealed that after heating an 18:8 steel at 600°-700° C. a darkening of the grain boundaries takes place. At 800°-900° C. a new phase, which consists of carbides, appears at the grain boundaries. V, Ti, Ta and other alloys which form more stable carbides than chromium carbides prevent carbide precipitation and consequently intercrystalline precipitation, whereas W and Mo which form less stable carbides are not so marked in resistance to intercrystalline corrosion. The good result of 18:8 steel with 5% Mo is not due to the carbides but to the change of austenite to ferrite structure. Ti carbide requires four parts Ti to one C in order to inhibit intercrystalline corrosion. In steel containing 0.14% C, 9.04% Ni, 18% Cr and 0.47% Ti heated at 1000° C. the titanium carbide did not dissolve, while at 1350° C. this carbide dissolved in austenite. One way to eliminate or to restrict intercrystalline corrosion is to produce an inoffensive separation of the carbides in the following manner: After cold rolling, the steel is heated to critical temperature in order to produce the precipitation of carbides at the grain boundaries and along the cleavage planes because this temperature is below that of recrystallization. The steel is then heated to a temperature equal to or higher than recrystallization temperature at which new grains are formed with no carbides precipitated at the boundaries of these new grains. Another way to check the intercrystalline corrosion is to produce a ferrite-austenitic structure by adding Si, Ti, V and increase the Cr content. The carbide precipitation also affects the mechanical properties. At 800° C. the physical properties are the lowest in all steels. Steels with Ti are better, whereas steels with W and Mo are not improved. The intercrystalline corrosion of soft steels is similar to that of the 18:8 steels. Brittleness produced by aging for 20 minutes at 250° C. is more effective than 500 days aging at room temperature. An ordinary soft steel worked 10% and aged for 1/2 hr. at 200° C. showed an impact of 2.1 kg/cm.² whereas Izett steel under similar conditions exhibited an impact value higher than 31 kg/cm.² GTM (13)

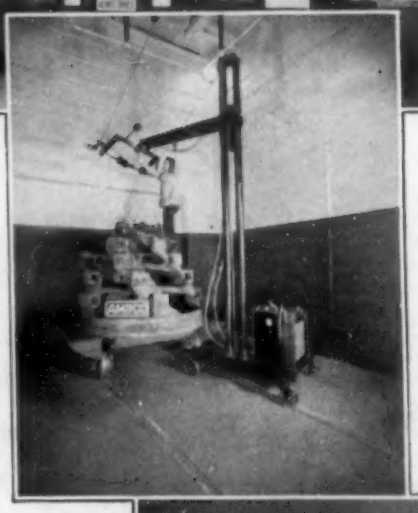
Maintaining Carrying Capacity of Cast-Iron Main by Introduction of Chloramines. GEORGE C. HODGES & J. WALTER ACKERMAN. *Journal American Water Works Association*, Vol. 27, Jan. 1935, pages 86-90. The use of chlorinators with ammoniators feeding into cast-iron pipe line carrying water, reduced tuberculation on inside of pipe. Supposed corrosion products on inside of pipe are judged to be due to iron fixing bacteria which are destroyed by the chloramine treatment since they do not form the deposit with the treatment. WB (13)

A LONG STEP.... TOWARD SOUNDER CASTINGS

Control stand, looking toward machine room.



Exterior view — AMSCO X-ray Laboratory.



Exposure room, showing X-ray tube stand—indicating flexibility of apparatus.

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Electrolysis of Telephone Cables. *Electrical Review*, Vol. 115, Dec. 28, 1934, pages 893-894. Describes experiences in Hong Kong with corrosion of Pb sheaths by stray currents from the electric railway. Conditions were improved by bonding the rail and cables at points near the power-plants and by erection of a booster connected to the negative return feeder. Other forms of corrosion were chemical attack of Sn of solder by sewage; acid action due to insects, particularly white ants; and chemical action of acids arising from rotting of the jute between Pb sheathing and steel armoring tape. MS (13)

Influence of Copper in small Amounts on the Corrodibility of Steels Ordinarily Employed in Structures (Influence du Cuivre en faibles teneurs sur la Corrodabilité des Aciers courants employés dans les Constructions métalliques). *Cuivre et Laiton*, Vol. 8, Jan. 30, 1935, pages 33-37. Results of tests made by the Soc. Anon. d'Ougree-Marihaye are briefly discussed which show that in an ordinary atmosphere as exists around industrial plants and residences steel with 0.5% Cu has a 2.5-3 times longer life than ordinary mild steel, both open-hearth and Thomas steel. Ha (13)

Corrosive Action of Different Cooling Brines on Individual Metals (Die korrodierende Einwirkung verschiedener Kühlsolen auf Einzelmetalle). M. Miethke & G. Witt. *Molkerei-Zeitung* (Hildesheim), Vol. 48, Apr. 1934, pages 842-843. Several brines were tested on various metals and compounds to determine corrosive action. After exposure for 30 days at —5° C. the change in weight was determined for each metal. The brines, indicated by trade names, were: (1) Reinhartin, 28° (Baumé), containing principally $CaCl_2.6H_2O$ and $MgCl_2.6H_2O$ in a 1:3 ratio, with added protective colloids and buffers; (2) Kühlsoleen, 22°; (3) Kühlsoleen special, 19°, containing $CaCl_2.6H_2O$ and $MgCl_2.6H_2O$ in a 1:3 ratio, with a silicate sediment; (4) Frigisol, 22°, containing $CaCl_2.6H_2O$ and $MgCl_2.6H_2O$ in a 1:3.7 ratio, with sodium chromate as an anti-corrosive; (5) Chromate—containing Reinhartin, 27°, similar to (1) containing sodium chromate; (6) Thermolyt, 22°, a calcium caloride brine; (7) Eissol, 22°, a calcium chloride brine; (8) Frigodur, 22°, a calcium chloride brine; (9) A brine made from industrial calcium chloride, 22°; (10) A brine made from industrial magnesium chloride, 22°; (11) A brine made from industrial sodium chloride, 22°; (12) Molkereisole, 36°, a carbonate-containing brine with added silicate. Metals tested were: (a) V2A welded steel, (b) cast iron, (c) wrought iron, (d) zinced iron, (e) zinc, (f) soldered tin, (g) tinned copper, (h) tinned brass, (i) chrome copper, (j) copper, (k) bronze, (l) red brass, (m) sheet brass, (n) cast brass, (o) aluminium, (p) Anticorodal, an aluminium alloy, (q) nickel, (r) Nicorros, a nickel alloy and (s) lead. (5) caused little or no corrosive action on any of the metals tried. (12) caused little or no corrosion on any except lead. (6) to (11) inclusive were especially corrosive to all the metals tried except (a) and (q); (1) was corrosive to all metals except (a) and (i); (2), to all except (a), (h) and (q); (3), to all except (a), (f), (g), (h), (l), (q) and (r); (4), all except (a), (f), (l), (o), (p), (q) and (r). GPS (13)

Corrosive Action of Various Cooling Brines on Metals in Contact (Die korrodierende Einwirkung verschiedener Kühlsolen auf kombinierte Metalle). W. Mohr & R. Kramer. *Molkerei-Zeitung* (Hildesheim), Vol. 48, Oct. 2, 1934, pages 2160-2162; Oct. 5, 1934, pages 2184-2187. Experiments are reported on the selection of metals and alloys resistant to brines used as refrigerants. Tests were made by immersing metals in brines and noting loss in weight and surface corrosion. When 2 different metals are in contact and immersed in a brine, galvanic action greatly increases the corrosion. Common metals undergo a marked electrolytic corrosion when used with noble metals. The measurable electric current generated is a criterion of the galvanic corrosion. Corrosion is proportional to brine temperature. Air, due to its O_2 content, increases corrosion markedly, e.g., when the brine is stirred. Frigisol, a 22° (Baumé) brine containing $CaCl_2.6H_2O$ and $MgCl_2.6H_2O$ in a 1:3.7 ratio and a small amount of Na_2CrO_4 caused corrosion in increasing order in these metals; V2A steel, Al, tinned Cu, brass, cast Fe, Cu, Fe, and zinc coated Fe. A 22° $CaCl_2$ brine caused more corrosion in an Al and Cu combination than in Al alone. In a stirred Frigisol brine, a Ni and Al combination produced an electric current which was smaller (< 0.1 milliamp.) and more constant than that produced by a Ni and Zn combination (0.2-0.6 milliamp.) or a Cu and Fe combination (0.06-0.5 milliamp.). Corrosion at the cathode is usually negligible; that at the anode is relatively great. Pb is especially susceptible to galvanic corrosion. Electrolytic Cr, like chromium-plated Cu, acts as the anode when in combination, and undergoes little or no galvanic corrosion. Ni is very resistant; V2A steel is even more resistant than Ni. In a Ni and V2A steel combination the steel acts as the anode and is decomposed only slightly. Nicorros, like Ni, is very resistant. Cu and its alloys are slightly corroded and the surface may become coated or colored. Sn, Sn-plated Cu, Sn-plated brass, Fe, and cast Fe are similar in resistance and are less resistant than Cu and its alloys. Pb is still less resistant. Soldering Sn is more resistant than Pb. Al is more resistant than Fe; it, however, became porous in all brines and its volume loss was similar to that of Pb. Zn and Zn-plated Fe are non-resistant. Addition of chromate to a brine greatly reduces the corrosive action. GPS (13)

Why Metals Stain the Skin. C. M. Hoke. *Metal Industry*, N. Y., Vol. 33, Apr. 1935, pages 127-128. There are 3 factors in the darkening or injuring of the skin from jewelry: (1) Composition; (2) Character of the perspiration; (3) Length of time since the article was cleaned. Cheap metals, if freshly cleaned, are not apt to discolor the skin. High grade jewelry, if long unused, is apt to stain. Perspiration contains chlorides, possibly sulphate, sulphides, and if acid in reaction, hydrochloric acid, and if alkaline, ammonia or related compounds. In recent years there have been noted skin eruptions apparently due to white gold. The ailments may be caused by Cr used as a plating. The use of S in ointments and soaps will usually be followed by a dark streak under each gold ring. Depilatories containing barium sulphide are efficient in darkening metals. Mercury ointment attacks gold. Medicine containing iodine probably appears in the perspiration as HI and discolors platinum. PRK (13)

Corrosion of Copper (Zur Frage der Korrosion von Kupfer). L. W. Haase. *Metallwirtschaft*, Vol. 14, Jan. 11, 1935, pages 32-33. Cu used for hot and cold water lines, hot water heaters and similar purposes is liable to form pin hole defects unless the water is sufficiently pure. If the water contains O and Fe_2O_3, local elements form which cause the corrosion of Cu. It was found that .3 mg./l. of Fe was enough to cause pin hole formation. Another type of corrosion is caused by a water-air line. This can usually be corrected by proper design of the installation. CEM (13)

Theory of Corrosion. III. (Zur Theorie der Korrosion. III). W. J. Müller. *Korrosion & Metallschutz*, Vol. 11, Feb. 1935, pages 25-34. The previously developed "covering theory" is extended. The protective action of metallic coatings is above all dependent on the stability of the oxide film of the metal. Intercrystalline corrosion is due mainly to the fact that the structure of the metal is interrupted in the grain boundaries and pores exist, therefore, mainly in the grain boundaries. As no covering layer without pores exists, metal in an electrolyte will be subject to corrosion due to formation of local elements. The degree of corrosion depends on the size of the pores. If this value remains at about 10^{-4} $cm.^2/cm.^2$ corrosion passivity exists. If the pores become larger by dissolving of the oxide layer, corrosion starts. The theory is applied specifically to rusting of iron. 12 references. Ha (13)

Local Element Effect in Corrosion Processes (Zur Theorie der Lokalelemententwicklung bei den Korrosionsprozessen). I. Stern & N. Nekrasov. *Physikalische Zeitschrift der Sowjetunion*, Vol. 5, No. 5, 1934, pages 729-745. The most probable scheme of a local element with concentric arrangement of the poles is considered. By theoretical deductions the mathematical expression for the resistance capacity of an ideal local element was found to be $2\sqrt{3\pi^3}\,(r_K - r_A)\,r_A^2$, wherein r_A and r_K = radius of anode and cathode zone respectively. A mathematical relationship between the total potential of a metal surface and the individual local potentials is given. The results are utilized in analyzing the electro-chemical changes of the Fe potential occurring in the course of corrosion. The active area of the Fe surface was computed and found to conform with the active areas of Fe catalyzers. This area is approximately 10% of the total surface area. EF (13)

The Electrochemical Theory of Corrosion. Oliver P. Watts. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 125-153; *Engineer*, Vol. 156, Sept. 15, 1933, pages 267-268. The 30th anniversary of the announcement of Dr. W. R. Whitney that the corrosion of metals is an electrochemical phenomenon seems an appropriate time for "taking account of stock" in the electrochemical theory of corrosion. Although the majority of students of corrosion now accept the electrochemical theory, there is apparently a wide difference of opinion regarding fundamentals of the process. It therefore seemed important that the opinions, the results of study and experimentation, should be brought together in a single paper, where the points of agreement and of difference might be apparent. Accordingly letters were written to eleven men prominent in the field of corrosion in England and the United States. The replies received, together with the editor's views, follow. LFM (13)

Corrosion of Zinc in Chloride Solutions. C. W. Borgmann & U. R. Evans. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 249-274; *Metallurgia*, Vol. 10, May 1934, pages 22-23. The research described aimed at studying the corrosion of zinc, in the cast and rolled conditions and in various degrees of purity, under conditions of partial immersion in potassium chloride solutions, sea water and distilled water. The results in potassium chloride solution show some striking differences from former experiments on wholly immersed zinc, and from those on iron (wholly or partly immersed). The corrosion of the sheet specimens continues to rise with the concentration, instead of falling off at high concentrations, as in cases where the corrosion rate is limited by "oxygen starvation." On the cast specimens, the absence of hydrogen evolution is a surprising feature. The results provide little hope of materially increasing the resistance of zinc to any of the liquids studied by eliminating or adding other metals, by protecting the cut edges or by avoiding abrasion of a rolled surface. (13)

The Protection of Iron in Aerated Salt Solutions by Cathodic Deposits. E. Herzog. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 87-98a. The polarization of the cathode areas on iron surfaces due to hydrogen films causes the cathode potential to approach that of the anode. The presence of oxide layers on the cathode areas facilitates this reduction in potential difference, even in the presence of O. Such oxide deposits appreciably retard the rate of oxidation of H at the cathode areas. Protective deposits may be obtained on an Fe surface by alloying with the Fe certain other metals. Autoprotective alloys are thus obtained. A marked improvement in corrosion resistance has been realized in this way by the addition of small quantities of Ni to Fe; in comparison with pure Fe a few % Ni doubled the resistance to corrosion in sea-water. On the basis of the principle of "protection by the suppression of local couples" giving rise to minute currents according to the classical electrochemical theory, we have arrived at the conclusion that protection can be obtained by utilizing the same local couples for the formation of cathodic deposits which retard the rate of attack. (13)

The Electrochemical Behavior of Iron in Corrosion Cells. I. The Iron Electrode Carrying No External Current. H. L. Lochte & R. E. Paul. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 155-172. This paper presents results obtained in a study of the iron electrode under no external current while immersed in various electrolytes under various conditions. Families of curves showing the relation between potential measured and size of electrode, oxygen concentration, temporary hydrogen evolution, change in pH, and type of anions present, are presented. Conclusions reached include one that the potential measured normally is due to a large number of half cells simultaneously active at different areas of the same electrode. These half cells include a film electrode that serves as hydrogen ion indicator but is not the hydrogen electrode. **II. The Cathode.** H. L. Lochte. pages 173-179. This article presents potential-time curves showing the effect of current density, oxygen concentration, and type of anion present on the potential of iron as cathode against zinc as anode. A number of regularities are pointed out. Current density-potential curves for the cathode under various conditions are presented and interpreted. **III. The Current Carrying Capacity.** H. L. Lochte. pages 181-188. The effect of current density on the potential of the 2 poles of Fe corrosion cells is determined for various conditions. In the absence of dissolved oxygen at the anode or in the presence of chloride type anions, polarization at the anode is negligible and corrosion is limited by cathode polarization. In the presence of phosphate type anions in aerated solutions, both anode and cathode are so extensively polarized that little damage can be done. Mixtures of the 2 types of anions show an effect in aerated solutions that depends on the ratio of concentrations of these ions and on the specific anions present. In the presence of such mixtures the anode tends to become more active with time as chloride type anions accumulate at it while phosphate type anions are held back in the form of insoluble corrosion products. (13)

The Role of the Corrosion Product in the Atmospheric Corrosion of Iron. W. H. J. VERNON. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 31-41. The role of the corrosion product is considered from the point of view of the primary (invisible) oxide film and the secondary rust. Formation of a continuous oxide film having protective properties is favored by screening the specimens from suspended particles in the atmosphere, which themselves give rise to a characteristic rusting, although the relative humidity may be considerably below the dew-point. A fundamental change in the rate of rusting (from a retardation to an acceleration) takes place at a critical humidity in the neighborhood of 65% saturation; this change is linked up with hygroscopicity of the rust. Additions to the iron of alloying elements may, it is suggested, act either by stabilizing the primary film or by reducing the hygroscopicity of the secondary rust. (13)

The Hydrogen Overvoltage of Iron-Chromium Alloys in Potassium Hydroxide Solution. M. DEKAY THOMPSON & D. M. FLEMING. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 221-226. The H overvoltages of the Fe-Cr series of alloys were measured in molal KOH solution at 25° C. No appreciable change in the overvoltage was found between 0 and 60% chromium; above 60% the overvoltage rises gradually to that of pure chromium in a curve that is concave upward. In the Fe-Ni alloys these curves are concave downward. (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Qualitative Experiments on Couples Formed by Differential Aeration and on the Passivation of Iron (Mémoires des travaux de la commission aéronautique pour l'étude de la corrosion. Expériences qualitatives rélatives au couple d'aération differentielle et à la passivation du fer). TRAVERS & AUBERT. *Revue de Métallurgie*, Vol. 31, Sept. 1934, pages 386-395. Couples caused by differential aeration, which were proposed by Evans, assume iron in active and passive state. Experiments were conducted to demonstrate the nature of this state. Many experiments designed either to facilitate or retard the access of oxygen to specimens immersed in salt solution showed that corrosion is a function of it, and that any steel oxidizes when oxygen can reach it. Immersion of iron specimens with differently finished or passivated surfaces in dilute CuCl solution showed that active and passive iron differs only in the speed of action on this reagent. Potentials of iron passivated in different ways are given. Passive and active iron are only relative terms, there is only a difference in degree. JDG (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Study of Homogeneity of Light Metal Alloys by Means of Coloured Indicators (Mémoirs des travaux de la commission aéronautique pour l'étude de la corrosion. Etude de l'homogénéité des alliages legèrs par la méthode des indicateurs colorés). PROT & GOLDOWSKY. *Revue de Métallurgie*, Vol. 32, Oct. 1934, pages 439-440. Specimens after proper cleaning are sprayed with a solution of sea water containing 100 g. of gelatine/l. When the gelatine sets, second and third coatings are applied. When the gelatine is allowed to act on the specimen for a few hours, a universal pH indicator is sprayed on top of it. The coloration appears instantaneously and is retained indefinitely. JDG (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Analysis of the Mechanism of Protection by Oxide Coatings (Mémoirs des travaux de la commission aéronautique pour l'étude de la corrosion. Analyse du mécanisme de la protection par dépôts d'oxydés). CHARLES BOULANGER. *Revue de Métallurgie*, Vol. 32 Oct. 1934, pages 441-442. Protective film of oxides formed by anodic oxidation and other means is uniform all over the surface, which was demonstrated photographically. The thickness of it varies. Lower dielectric layer of oxide is always the same; the upper, conductive layer is much thicker and varies with the concentration of the electrolyte. The physical nature of the deposit cannot be determined as yet. The same mechanism of protection applies to Zn and Mg. JDG (13)

Reconditioning of Pipe Lines is Fast Becoming of Primary Importance. E. C. ROLFS. *Oil & Gas Journal*, Vol. 33, Oct. 25, 1934, pages 97-98. Location of the line, uncovering, cleaning and recoating are described. VVK (13)

A Reflectivity Method for Measuring the Tarnishing of Highly-polished Metals. L. KENWORTHY & J. M. WALDRAM. *Metal Industry*, London, Vol. 45, Sept. 28, 1934, pages 299-301. Paper presented at the Autumn Meeting of the Institute of Metals. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 540. HBG (13)

Texture and Chemical Resistance. C. H. DESCH. *Industrial Chemist*, Vol. 10, Nov. 1934, pages 413-416. A lecture before the Institution of Chemical Engineers, Oct. 1934. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 124. RAW (13)

X-ray Investigation of the Corrosion Mechanism in Solid Solutions (Röntgenuntersuchung des Korrosionsmechanismus bei Mischkristallen). L. GRAF. *Korrosion & Metallschutz*, Vol. 11, Feb. 1935, pages 34-42. The possibilities of using X-rays to elucidate molecular and atomic phenomena in the corrosion process and thus to obtain a better insight into the nature of and conditions for corrosion are discussed. Ha (13)

Theory of Phenomenon of Passivity. 26. Boundary Currents in Anodic Polarization of Metals in Water Solutions. (Zur Theorie der Passivitätserscheinungen. 16. Ueber die Grenzstrome bei anodischer Polarisation von Metallen in wässrigen Lösungen). W. J. MÜLLER. *Zeitschrift für Elektrochemie*, Vol. 41, Feb. 1935, pages 83-86. The progress of the coating of crystalline salt formed on metals is shown in current density-time curves. The progressive coating of the metal is also shown in a series of polarizing-microscope photos of the metal surface which are superimposed on the current density-time curves and follow the curves down continuously to passivity or zero current. The fact that at saturation of the solution with the salt the coating of the metal begins and follows the curve down slowly, is considered by the author the main point against E. Miller & K. Schwabe's published contention that the formation of the coating is a secondary phenomenon. Author's curves show that there is no polarization at the point of saturation, which is opposed to the requirement of E. Miller's theory. He considers his surface-coating-theory-of-passivity able to interpret supposedly anomalous results reported by E. Miller and therefore not vitiating the power of the original theory for explanation of passivity phenomenon. WB (13)

Adhesiveness of Rennet-coagulated Milk to Cheese Kettles Made of Various Metals (Ueber das Anhaften der labgeronnenen Milch an Käsekesseln aus verschiedenen Metallen). A. PETER & E. MÄDER. *Schweizerische Milchzeitung*, Vol. 61, Jan. 11, 1935, page 13. In cheese-making the rennet-coagulated milk adheres to the surface of the kettle and must be rubbed off; this interferes with the normal breaking of the curd. The adhesiveness was found to vary for different metals. Surface friction tests, under standard conditions gave: bare Cu, 2.25., tinned Cu, 29 g., Al, 15 g., unpolished steel, 21 g., polished steel, 20 g. Adhesion depended upon the metal used and not upon the extent to which the surface was polished. For sweet milk cheeses, e.g., Cu kettles are preferable. For cheeses in which acidity develops during making, and most soft cheeses, Cu may dissolve and cause a blue color; in such a case stainless steel, tinned Cu, or Al are preferable. In equipment for processing milk, cream or condensed milk, dissolved Cu may catalyze oxidation processes and cause oxidized or rancid flavors; in such cases stainless steel is recommended. GPS (13)

Prevention of Attack of Water on Light Metals (Zur Verhütung des Angriffs von Wasser auf Leichtmetall). H. RÖHRIG & K. KREKELER. *Aluminium*, Vol. 17. Nov. 1934, pages 140-141. A series of experiments showed that a small addition of a protective oil which emulsifies with water not only restores the vibration strength which is reduced by wetting with water, but also prevents every attack of water on light metal, especially so at higher temperatures. The oil forms a thin film on the surface which prevents the attack effectively even if the specimens are exposed to boiling water. Ha (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Standardization of the Methods Used for Determination of Corrosion in Artificial Sea Water (Mémoirs des travaux de la commission aéronautique pour l'étude de la corrosion. Normalisation des méthodes pour l'essai des métaux à la corrosion par l'eau de mer artificielle). LEGENDRE. *Revue de Métallurgie*, Vol. 32, Oct. 1934, pages 442-449. Proposed standardization of the factors entering corrosion test in artificial sea water. JDG (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Study of the Standard Sea Water and the Influence of the Composition and Replacement of the Corroding Liquid in Corrosion Testing (Mémoirs des travaux de la commission aéronautique pour l'étude de la corrosion. Etude de la composition de l'eau de mer normalisée et influence de la composition et du renouvellement du liquide d'attaque dans les essais de corrosion). QUILLARD. *Revue de Métallurgie*, Vol. 32, Oct. 1934, pages 449-451. For standard sea water the commission selected a solution of 300 g. NaCl, 1.876 g. disodium phosphate, 12.404 g. H_3BO_3 in 10 l.H_2O. It is adjusted to the desired pH with sodium carbonate solution. Addition of $MgCl_2$ and $MgSO_4$ to a 3% NaCl solution has given discordant results with the general trend that their addition either separately or together does not increase the corrosion of duralumin. Similar experiments conducted on solutions to which H_2O_2 was added indicated that the sensitivity of the corrosion test does not increase on Mg ion addition. Alternating immersion tests showed both qualitative and quantitative influence of the composition of the solution used for corrosion, both on ferrous and non-ferrous alloys. Corrosion in stationary and running aerated solution of sea salt and city water showed an increase of 2.5 times and 1.5 times respectively for city water and salt solution for the latter case. JDG (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Estimation and Measuring of Corrosion (Mémoires des travaux de la commission aéronautique pour l'étude de la corrosion. Sur l'appréciation et la mésure de la corrosion). JEAN COURNOT & MARCEL CHAUSSAIN. *Revue de Métallurgie*, Vol. 32, Nov. 1934, pages 487-490. Summary of the observations to be made in corrosion testing. Rust removal with NaOH + Zn is recommended. JDG (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Indices of Corrosion (Mémoires des travaux de la commission aéronautique pour l'étude de la corrosion. Note sur les indices de corrosion). PROT & GOLDOWSKI. *Revue de Métallurgie*, Vol. 32, Nov. 1934, pages 490-494. Factors entering corrosion tests are reviewed. An apparatus is described in which a continuous flow of the corrosive liquid is maintained. Run off liquid is filtered, specimen cleaned with acid, solids recovered on the filter added to it and the metallic content determined. The loss of weight determined by weighing the specimen checks closely the values recovered from the solution. The weight divided by the area of the specimen serves as the index of corrosion. On light Al alloys the accuracy of the determination is within 3%. JDG (13)

The Scientific Study of Protective Painting. S. C. BRITTON & U. R. EVANS. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 43-58. Includes discussion. See "Protective Painting of Metal Work," *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 539. (13)

The Protective Action of Lead Pigments Against Rust. MANFRED RAGG. *Transactions Electrochemical Society*, Vol. 64, 1933, pages 59-68. As compared with other pigments, red lead has a decided protective value when applied as a paint to iron and steel surfaces. The vehicle of the paint interacts with the lead oxide, forming comparatively insoluble complex glycerates and basic lead soaps which cement the pigment particles together, strengthen the paint film and make it waterproof. The electrochemical interaction between the lead oxide and the metallic iron of the surface appears to be of secondary importance as far as rendering the iron resistant to rust is concerned. The insoluble lead compounds formed during aging or storage of red lead paints are investigated at length. (13)

Various Aspects of Corrosion (Varios Aspectos de la Corrosion). J. F. LEVY. *Boletin de la Sociedad Quimica del Peru*, Vol. 1, Oct. 1934, pages 32-49. Chemical and microscopical examination shows some differences in the rails, e.g. combined C percentage, but of much greater significance in the percentage of soluble salts in the soils in the 2 districts. The larger the quantity of soluble salts in the soil the greater has been the corrosion. Rails laid in 1893-1905 where the soil contains less than 0.5% soluble salts were in the best condition and much less corroded than rails much more recently laid in soils containing as high as 8.23% organic matter and 26.64% soluble inorganic salts. Seasonal variations of soil moisture and even morning-afternoon soil moisture variation may have set up different concentration conditions favorable for galvanic cell action to accelerate corrosion. Variations in temperature and enclosed impurities in the steel are also factors. The existence in incrustations on the rails of chloride, sulphate and calcium radicals indicate the galvanic cell type of corrosion as a factor. Oden E. Sheppard. (13)

Cause of Corrosion in Alkali-Knoll Soils. WALTER F. ROGERS, *Proceedings American Petroleum Institute, Division of Production*, Vol. 15 (IV), 1934, pages 38-44. It has been found through experience that pipe lines on the Gulf Coast which pass through "alkali-knoll" soils are subject to a much higher corrosion rate (usually 20 to 30 mils per year) than found in adjacent clay or clay-loam soils. An examination was made of the soil texture of a number of these alkali knolls, and it was found they were composed largely of sand and silt particles—the clay content being very low or missing. To determine the cause of the high corrosion rates obtained in these soils, a study was made of two alkali knolls and one adjacent, but non-corrosive, clay loam soil. The study included the determination of the annual soil-moisture variation, the electrical resistivity, soil texture, etc. In addition, the effect of various water concentrations on the corrosiveness of each soil was obtained by a laboratory test. The combination of the data from the field and laboratory measurements shows that the clay loam was too wet to give rise to rapid corrosion rates while the alkali-knoll soils were in a state of effective corrosion at all times. 3 references. VVK (13)

The Protection of Pipes Against Soil Action. K. H. LOGAN. *Transactions of The Electrochemical Society*. Vol. 64, 1933, pages 113-124. The electrochemical phenomena which result in underground corrosion of ferrous metals seem to originate principally in concentration cells. It follows that corrosion may be reduced by reducing the number and potential differences of these cells. Several methods for accomplishing this are briefly discussed. Rust films are found to offer some but inadequate protection. Metallic coatings protect primarily because of the films which form on them. Thick cement mortar coatings have proved effective. A thinner coating of this type has been developed, but available data are insufficient to indicate its permanent value. Its value in the so-called alkali soil of the West is doubtful on account of the effect of some of these soils on concrete. Bituminous coatings when reinforced by fabric appear to be fairly satisfactory, but they have some undesirable properties. Cathodic protection of coated and uncoated pipes is discussed briefly. There is a need for a field test for coatings and two possible tests are described. (13)

Important Developments Show Constructive Progress in Oil Pipe Line Operation. W. G. HELTZEL. *Oil & Gas Journal*, Vol. 33, Oct. 25, 1934, pages 36-48, 102. A comprehensive review of the changes that have occurred in the methods and practices of pipe line operation since 1927 followed by a detailed description of a modern pipe line reconditioning job. VVK (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Accelerated Corrosion Testing Methods for Iron and Duralumin in Aerated Salt Solutions (Mémoires des travaux de la commission aéronautique pour l'étude de la corrosion. Note sur les méthodes d'essais accelerés de corrosion du fer et des duralumin dans les solutions salines aerées). E. HERZOG & G. CHAUDRON. *Revue de Métallurgie*, Vol. 32, Dec. 1934, pages 560-566. Survey of factors entering accelerated corrosion, precautions to be observed and conditions to be fulfilled. JDG (13)

Reports of the Aeronautical Commission for the Study of Corrosion. Study of the Light Diffused by Sheets of Pure Aluminum and Duralumin Corroded for Different Lengths of Time (Mémoires des travaux de la commission aéronautique pour l'étude de la corrosion. Etude de la lumière diffusée sur des plaquettes d'aluminium pur et de duralumin normal corrodées suivant des temps croissants). CANAC & GRANVEAUD. *Revue de Métallurgie*, Vol. 32, Dec. 1934, pages 566-567. Curves obtained with a luxmeter on Al and duralumin sheets corroded in NaOH + H_2O_2 for from 15 seconds to 6 minutes are given. Their shape is different. JDG (13)

Refining the Salt of the Earth. JAMES A. LEE. *Chemical & Metallurgical Engineering*, Vol. 42, Mar. 1935, pages 124-128. A general description of salt refining is given. The corrosion rates of nickel, Monel and Ni-Resist in brine under various conditions were given.

	Corrosion Rate, inch penetration per year				
	Saturated	Saturated Salt spray steam, air	Rotary vacuum Salt dryer sat. brine	Oil fired Salt dryer	Steam heated dryer
	brine, 180° F	200° F	hot air	28 ft. from feed end	
Monel	0.00016	0.0027	0.0002	0.009	0.0002
Nickel	0.0002	0.0022		0.011	0.00007
Ni-Resist	0.0003	0.005	0.0016		

PRK (13)

The Corrosion Problem with Respect to Iron and Steel. FRANK N. SPELLER. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 113, 1934, pages 13-33. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 463. (13)

Recent Developments in the Manufacture of Sucker Rods. B. B. WESTCOTT & L. W. VOLLMER. *Oil & Gas Journal*, Vol. 33, Oct. 18, 1934, pages 35-40. Paper before the A. I. M. E. Petroleum Division, Oct. 1934. ("Development in the Manufacture of Sucker Rods"). Development and changes in design of sucker rods are described. Increased strength and resistance to corrosion are being sought in the low alloy steels. Nickel wrought iron has been very satisfactory for sulphide wells. A number of other alloys are under test and show promise. Physical properties and suitable service conditions are given for 11 materials. VVK (13)

Boiler Feedwater Problems and their Correction. *The Locomotive*, Vol. 40, Jan. 1935, pages 130-141. The quality of feedwater and its bearing on corrosion and embrittlement of boiler materials, and means to correct the properties of the water for a given case are discussed at length. Ha (13)

Cable and Sheath Corrosion—Causes and Mitigation. J. B. BLOMBERG & NORVEL DOUGLAS. *Electrical Engineering*, Vol. 54, Apr. 1935, pages 382-387. The causes and mitigation of telephone cable sheath corrosion are outlined and a method described of applying a counter potential to the cable sheath for mitigation of corrosion from localized currents. Available methods for the reduction of corrosion on underground cable are: (1) to maintain the cable free from moisture and contact with the ground water, and (2) to maintain the cable slightly negative to the ground water with which it is in contact. WHB (13)

14. APPLICATION OF METALS AND ALLOYS

Metals Used in the Oil Industry. *Metal Progress*, Vol. 27, Apr. 1935, pages 47-51. Summarizes papers presented at meeting of A.I.M.M.E. A low C 2.25% Ni steel is reported most satisfactory for the sub zero temperature employed in dewaxing equipment. 25-12 Cr-Ni casting is recommended for heat resisting applications though lower alloys may be employed where temperatures are not so high. Higher Cr, 29%, should be employed in serious S corrosion and 2-4% W may be added as a strengthener. Cr-Ni alloys where Cr is 25% or over are resistant to practically all services of liquid corrosion though where HCl is the active corrosive, Cu-Ni, Cu-Zn and Si cast iron are superior. For heat exchangers bronze alloys, 4-5% Cr and plain carbon steel are used, given in their preferred order. In pumps where abrasion from various sources may enter Fe alloys are employed with "Ni-resist" cast iron, nitrided steel or parts with "stellited" surfaces. Impellers of 18-8 and 25-12 are highly resistant to corrosion. WLC (14)

Change in Catalytic Activity of Metals at Transformation Points (Die Änderung der Katalytischen Wirksamkeit von Metallen am Umwandlungspunkten). KURT FISHBECK & FRANZ SALZER. *Zeitschrift für Elektrochemie*, Vol. 41, Mar. 1935, pages 158-169. There is an abrupt decrease in catalytic activity of metals at transformation points where there is a change to the high temperature modification as in the dissociation of NH_3 with Fe and the hydrogenation of CO_2 with Co-Ni catalyst. For Ni and Ni-Cu alloys at the temperature where loss of magnetism occurs no continuous change in catalytic properties could be observed. WB (14)

Recent Use of Rare Elements in Commercial Alloys (Die neuzeitige Auswertung des Reiches der technischen Legierungen durch Einbeziehung der seltenen Elemente). W. GUERTLER. *Chemiker-Zeitung*, Vol. 58, Dec. 1, 1934, pages 969-970. Li is used in Pb alloys, Be in Cu alloys, Ca, Sr and Ba in Pb alloys. B is used in place of C in hard cutting alloys, and Zr in steel. CEM (14)

Strip and Sheet Material—Characteristics of Commercial Supplies and Their Relation to the Requirements of the User. P. MABB. *Machinery*, London, Vol. 45, Jan. 24, 1935, pages 574-576. Tolerances of length and thickness of brass, Cu, phosphor-bronze, nickel silver, Al, bright mild steel and black Welsh plate strip for forming operations on automatic machines. Rolling requirements as affecting these materials are discussed. WB (14)

New Steels Play Big Role as Railroads Modernize. *Steel*, Vol. 96, Jan. 7, 1935, pages 119-121, 259. Discusses rehabilitation of rolling-stock with special attention to use of alloy steels and Al. MS (14)

Enhanced Properties Extend Uses of Modern Castings. *Steel*, Vol. 96, Jan. 7, 1935, pages 158-159, 275-278. Reviews progress in the foundry industry during 1934. MS (14)

In a Meter Factory. *Electrical Review*, Vol. 116, Jan. 18, 1935, page 96. Outlines some of the processes in the manufacture of electric meters in the plant of the English Electric Co., Stafford, England. Use castings, steel ball-bearings, brake magnets, and Al rotors. MS (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Duralumin in Aircraft Construction. F. P. LAUDAN. *Metal Progress*, Vol. 27, Apr. 1935, pages 39-42. Discusses the use of duralumin in all metal aircraft construction and the changes it has brought about in aircraft shop practice and equipment. WLC (14a)

Light Metals in Transport Engineering (Leichtmetalle im Transportwesen). M. KOENIG. *Aluminium*, Vol. 17, Feb. 1935, pages 53-57. Practical viewpoints for their selection and treatment are discussed. Ha (14a)

Development of Aluminum Industry, Particularly With Regard to Recent New Applications of Aluminum (Aluminiumindustriens utvikling saerlig med henblikk paa nye anvendelser av aluminium i den senere tid). S. KLOUMANN. *Teknisk Ukeblad*, Vol. 82, Feb. 21, 1935, pages 76-78. Review of paper presented before Polytechnic Society of Norway, at meeting in Oslo Feb. 12, 1935. Discusses development of present processes for production of Al and lists uses in food industries, power transmission, bridge construction, architecture, shipbuilding, transportation, aircraft construction, and in paints. Consumption of Al in the packing industry is increasing rapidly in Norway. In 1934 about 10,000,000 Al cans were used by the fish canneries, corresponding to 250 metric tons, compared with 2,000,000 cans in 1935. The total amount required if all tin cans were replaced in this industry would be about 6,000 tons Al. BHS (14a)

Palladium-Silver Alloys for Dental Work (Palladium-Silber-Legierungen für Zahnersatz). J. SPANNER. *Metallwirtschaft*, Vol. 14, Feb. 15, 1935, pages 132-133. During the last 3 years Pd-Ag alloys have been used for dental work, partly replacing the more expensive Au alloys. They contain 20 to 30% Pd, up to 10% Au and Cu, and sometimes small amounts of other metals. Their sp. gr. is 10.5 to 11.5. They are corrosion resistant, can be cold worked, and are available in soft, medium, and hard grades. Their Brinell hardness varies from 43 for some of the annealed to 238 for some of the heat treated alloys. A typical heat treatment consists of heating to 850° C., quenching, and drawing at 650°. This treatment results in precipitation hardening. CEM (14a)

Copper and Its Alloys in the Fixtures of Show Windows in Paris Stores (Le Cuivre et ses Alliages dans les Devantures des Magasins de Paris). H. Bréau. *Cuivre et Laiton*, Vol. 8, Feb. 15, 1935, pages 57-59. Describes application of Cu, brass and bronze in various forms. Ha (14a)

Aluminum in Chemical Plants. F. C. Frary. *Chemical Industries*, Vol. 35, Dec. 1934, pages 499-503. See "Aluminum in the Chemical Industry," *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 79. RAW (14a)

Nickel and Its Alloys in the Service of the Architect (Le Nickel et ses Alliages au Service de l'Architect). Galibourg. *Usine*, Vol. 44, Jan. 31, 1935, page 29. Review of applications of Ni and Ni alloys in architectural designs and their properties. Ha (14a)

New Materials Used in Baltimore & Ohio Freight Cars. G. L. Lacher. *Iron Age*, Vol. 134, Sept. 20, 1934, pages 24-27. Five tons of revenue freight to every ton of dead weight in open-top car is the bogey of B. & O. R. R. In pursuit of this aim sample cars have been built of corrosion resistant materials in which dead weight has been reduced. Describes the construction of a hopper car built of Al alloy. Includes information on investigation made on relative influence of atmosphere and lading on corrosion and has found a large proportion of rust loss due to former. VSP (14a)

Color Formation in Glasses and Glazes. F. H. Norton. *Glass Industry*, Feb. 1935, pages 45-48. A theoretical treatise on the methods of color formation as related to atomic structure and position in periodic table of the various metals used in production of color or in modification. An extensive bibliography on color production is given. WB (14a)

Application of Beryllium Alloys in Watches and Clocks (Verwendung von Beryllium-legierungen in Uhren). W. Rohn. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Jan. 5, 1935, pages 22-23. Alloys of Ni, Mo and Fe with 1% Be and of Ni, Cr, Mo with Be are non-magnetic and entirely corrosion-proof. They are used for springs as they have a practically negligible temperature coefficient. The great hardness sometimes makes them suitable to replace even sapphire bearings. Cu-Be alloys can be used in place of steel parts; they are heat-treated after having been formed by keeping them at 230°-420° C. for several hours. Ha (14a)

Antifriction Alloys on a Lead Basis and High Copper Content (Alliages à Frottement à Base de Plomb et à haute Teneur en Cuivre). A. Ricard & H. Ackermann. *Cuivre et Laiton*, Vol. 8, Feb. 28, 1935, pages 85-87. The triangular diagram of the system Cu-Sn-Pb is used to show and explain the ranges of the best characteristics of this alloy as antifriction metal, i.e., very low friction coefficient, high compressive resistance, and good heat conductivity. Pb must not be less than 2.5%, Sn not less than 5%. The wear resistance does not change materially for changes in Pb from 12-15%, but the mechanical properties deteriorate noticeably and very rapidly beginning at 15%. Bronzes rich in Pb have a certain self-lubricating property. Ha (14a)

Transmission Lines of Aluminum and Aluminum Alloys (Freileitungen aus Aluminium und Aluminiumlegierungen). H. Wiesthaler. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Jan. 26, 1935, pages 105-110. Use of Al and Al-steel for transmission lines, joining of wires by clamps and welding, fittings, strength under vibration strains, and construction of stranded ropes to eliminate or reduce torsion and vibration are discussed at length. Use of Al is compulsory in Germany in place of Cu for transmission lines above 10 mm. diam. 15 references. Ha (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

Experiences in Construction of High-Pressure Pipe Lines (Erfahrungen im Bau von Hochdruck-Rohrleitungen). C. Marscheider. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Mar. 2, 1935, pages 292-298. Economy and particular requirements in building pipe lines for high pressures are discussed on the basis of past experiences. With regard to selection of the material, whether alloy or ordinary C steel, it was found that it is more economical to use an alloy steel if the ratio creep strength of alloy steel to creep strength of C steel is greater than the ratio of price/kg. of alloy steel to C steel; it is assumed that both lines are figured for the same safety and that for temperatures over 350° C. the creep strength is used in above formula, while below 350° C. the room temperature elastic limit is used. C steel should be used at high temperatures if the calculated wall thickness for small diameter is less than the standard wall thickness for such pipes. Ha (14b)

Pure Iron for the Enamelling Industry. N. H. Oakley-Evans. *Engineering*, Vol. 139, Feb. 1, 1935, pages 127-128. **Enamelling Iron.** *Heat Treating & Forging*, Vol. 20, Dec. 1934, pages 600-604. Abstract of a paper read before the Institute of Vitreous Enamellers, Southern Section, London, Oct. 1934, and Northern Section, Oct. 1934, entitled "Enamelling Iron." Deals with characteristics of pure Fe made to meet the needs of enamelling industry and refers to some of the difficulties encountered in enameling process. Typical high grade enameling Fe contains: 0.025% C, 0.030% Mn, 0.009% P, 0.035% S and trace of Si. Approximate physical properties are: tensile strength 20 tons/in.², yield point 70% of tensile strength, elongation 25% in 8 in., and Rockwell hardness (B scale) 40. The values vary with individual requirements. VSP + MS (14b)

Steel Reinforcement Prolongs Life of Bituminous Pavements. *Steel*, Vol. 95, Dec. 24, 1934, pages 28-29. In Europe, good results have been obtained in the elimination of ruts, corrugations, and cracks in bituminous pavements, by imbedding in the pavement a rigid 2-way steel mesh reinforcement which resists horizontal movement. Duplex Steel Reinforcement Co., Liberty, Ind., has developed a rigid diamond shape mesh formation, made up of steel bars, edge set, and clipped together. MS (14b)

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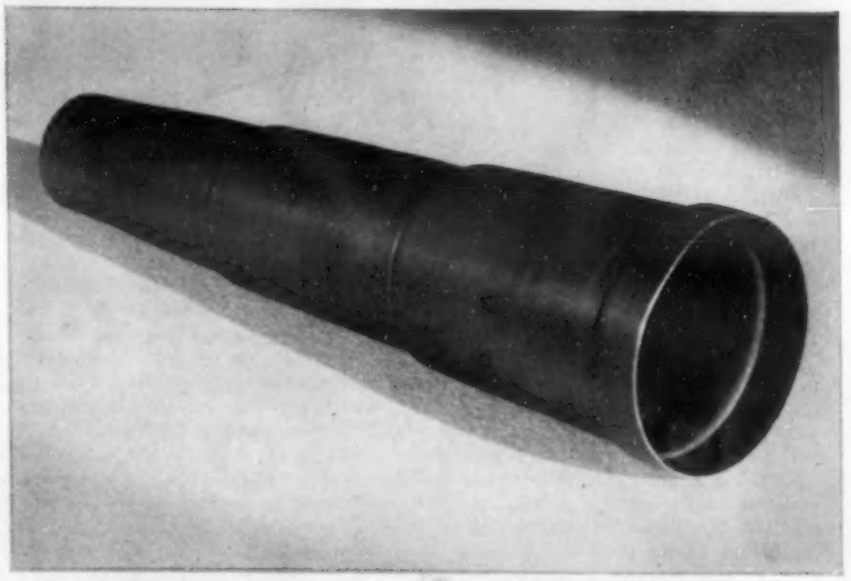

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Electric Heating Elements. A. G. POWELL. *Electrical Review*, Vol. 115, Dec. 28, 1934, page 918. Brief discussion of 80% Ni-20% Cr and 65% Ni-15% Cr-20% Fe heating elements. Former is used for higher temperatures. Practical working limit of latter is about 850° C. MS (14b)

Steels in Wood Working Industries (Les Aciers durables dans les Industries du Bois). PETITPAS. *Usine*, Vol. 44, Jan. 24, 1935, page 35. Various steels were tested with respect to their suitability for wood-working. High-speed steels proved less resistant than steels with lower W content. A chart is developed which permits selecting a certain steel for working a given kind of wood and determining the time before resharpening the tool. Ha (14b)

Heat and Cold Insulation—A New Field of Application for Sheet Steel. JOSEPH F. SHADGEN. *Iron Age*, Vol. 135, Jan. 17, 1935, pages 8-14. Iron and steel have a definite place in massless type insulation. Low price of raw material and its availability favor the use of standard Fe and steel sheets in gages around 38 and 42. These sheets are rolled in widths varying from 24 to 48 in., which reduces the number of joints about 75% when compared with Al or Zn. Investigations have established that emissivities below 20% are specific to black steel sheet surfaces and rolled commercial sheets with values less than 10% are available. Includes a table of emissivity values for various metals and paints. VSP (14b)

Alloy Steel and Cast Iron Progress. J. W. SANDS. *Industrial Heating*, Vol. 2, Mar. 1935, pages 121-126, 134. A general review of recent developments in alloy steels and alloyed cast irons necessitated by light yet very strong materials in high-speed railway service, for use at very low temperature and in high-pressure vessels. Examples and figures are given. Ha (14b)

The Deep Drawing of Sheet Steel. L. B. HUNT. *Machinery*, London, Vol. 45, Feb. 28, 1935, pages 721-725. Properties desired in sheet for forming operations in automotive trade are discussed. Type of plastic movement desired in the press is best brought about in the hot rolled sheet, box-annealed or normalized. Prolonged annealing produces material too soft to withstand stretching strains around bends or corners. Best practice is to normalize at 900° C. and thus obliterate entirely the distorted and strained structure of the hot-rolled material and replace it with an entirely recrystallized structure having a finer grain size than that produced by annealing. Exact control of grain size is necessary, too small a grain gives low ductility while if grain size is allowed to grow too large the material will stretch rather than flow in the dies. Ratio of yield stress to max. stress should not exceed 65%. For deep drawing a Rockwell hardness of B40 to B55 with Erichsen value not less than 10.5 m.m. or Olsen value not less than .380". Criticism of cupping tests is that the specimen is subjected to practically all stretching with an insufficient amount of circumferential compression to resemble the actual drawing operation. The relationship between yield-point elongation and the severity of stretcher-straining is pointed out with the conclusion that sheets having a well marked yield point will show stretcher strains while material giving a smooth curve will not. Roller levelling gives a repeated, slight bending action, producing sufficient deformation without unduly affecting ductility. Because of aging after cold-work, roller levelling should be carried out on the same day as the press operation. WB (14b)

Filling Stations of Steel and Steel-Eternit (Tankwärter-Stationen aus Stahl und Stahl-Eternit). WILHELM ZIMMERMANN. *Montanistische Rundschau*, Vol. 26, Dec. 16, 1934 (Section *Stahlbau-Technik*) pages 4-5. A light construction of filling stations involving the use of steel plates and eternit, (asbestos-cement composition), whereby a light structure is obtained which may easily be moved from one location to another if desired. BHS (14b)

Development of Steel Construction (Zur Entwicklung des Stahlbaues). FRANZ ZELISKO. *Montanistische Rundschau*, Vol. 27, Feb. 16, 1935 (Section *Stahlbau-Technik*) pages 1-5. Discusses use of structural steel in bridge construction and architecture. Author reviews development over the last 100 years and draws attention to the great progress made in steel manufacture since the War, with commercial steel of greater homogeneity and freedom from inclusions, having tensile strengths 25 to 50% above that of the pre-War period. With proper calculations and design it should therefore be possible to go to lower factors of safety. Modern methods of welding offer additional advantages. BHS (14b)

Materials for Permanent Magnets. L. SANDERSON. *Heat Treating & Forging*, Vol. 21, Jan. 1935, pages 13-14. Original W magnet steels were soon supplanted by Co magnet steels developed first by Honda in 1916. In 1931, Köster developed a steel containing Co and Mo or W, which had a remanence of 12,000-6,700 and coercive force of 100-350, when cooled from 1300° C. and tempered at 600° C. Also in 1931, Mishima produced a steel with 30% Ni and 12% Al, which had a remanence of 11,000-7,500 and coercive force of 200-700. This steel is lighter and cheaper than the Co steels. Its greatest disadvantage is difficulty in forging, so that magnets have to be cast and finished by grinding. In 1933, Kato made permanent magnets by sintering a mixture of Fe_2O_4 and $CoFe_2O_4$ at 1000° C. Magnets are said to have coercive force of 400-600, remanence of 5,000-3,000, tenacity about ½ that of Fe, and good resistance to heat and shock. They are, however, low in magnetism and extremely brittle. Also in 1933, Honda perfected a magnet steel containing 15-36% Co, 10-25% Ni, and 8-25% Ti. Most suitable properties are obtained by cooling from the half-molten condition and tempering at 60° C. Addition of a small amount of Al improves magnetic properties. Typical remanence is 7,600, with a coercive of 788. Alloy has a Rockwell hardness of 63 in the cast condition, 60 when tempered at 660° C., with a density of 7.3. Magnets are resistant to heat and shock, but are difficult to forge. A magnet steel has recently been patented in which high Si replaces Ni. MS (14b)

Recent Progress in Aviation Motors (Les derniers progrès des Moteurs d'Avions). EDMOND MARCOTTE. *Revue combustibles liquides*, Vol. 12, Oct. 1934, pages 335-345. This is a discussion relating to the different parts of the motor and to the metals used. With steels, the best results are obtained from those ranging between 13% Cr, more resistant or hard, and 13% Mn, most resilient or tough. The best steels known are Cr-Mo alloys, which surpass Ni-Cr, Ni, Ni-Mo and the finest carbon steels. The extra light alloys of Mg-Al-Ni in use corrode easily. HS (14b)

1

Manufacture and Properties of Isteg-Iron (Herstellung und Eigenschaften des Istegeisens). K. SCHÖNROCK. *De Ingenieur*, Vol. 50, Jan. 4, 1935, pages Bt.3-Bt.7. Instead of the simple round or square Fe rods used in reinforced concrete, another shape—Isteg iron—was developed which is made of 2 closely adjacent, round rods gripped tightly on both ends and twisted so that the axis of the 2 rods retains the same length as the single rods previous to twisting; this stretching process is carried out in special machinery and a high grade structural open-hearth or Thomas steel (German standard St 37) is used. The dynamic properties of such cold-worked rods are superior to steels in the original state. Curves of mechanical properties compared with round bars are given and a few examples of their application in concrete described. Ha (14b)

2

Pave Roads with Iron Blocks. E. W. DAVIS. *Foundry*, Vol. 62, Sept. 1934, pages 24-25, 46. See "Cast Iron Blocks Prolong Life of Road Surfaces in Europe," *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 543. VSP (14b)

Engineering Notes. *World Power*, London Vol. 23, Jan. 1935, page 32. A heat-resistant alloy steel Calumet Cr-Ni-Al is used for castings. These have strength at high temperatures, oxidation resistance up to 1050° C., corrosion resistance to S gases and non embrittlement in service. The physicals of the material are reviewed and the heat treatment is given. WB (14b)

3

Water Main Failures. ARTHUR H. MILLER. *Journal American Water Works Association*, Vol. 27, Jan. 1935, pages 53-62. Failures in cast-iron water pipe are detailed and found to be due to poor quality casting. "Failures of this nature tend to encourage the use of substitute material for cast-iron water mains." The discussion of the paper brings out control factors for specifying castings and preventing failure. WB (14b)

Large Uses of Steel in Small Ways. No. 275. Tobacco Cask Hoops. *Steel*, Vol. 95, Dec. 3, 1934, page 34. From 1500-1800 tons of hot-rolled beaded hoops are required annually for tobacco casks. MS (14b)

4

Large Uses of Steel in Small Ways. No. 276. Hacksaws. *Steel*, Vol. 95, Dec. 17, 1934, page 42. Blades for power and hand hack-saws offer a substantial market for alloy steel strip, low W and high speed steels generally being used. Sawing-machines are made principally of cast Fe, although certain parts are of rolled steel. MS (14b)

Large Uses of Steel in Small Ways. No. 277. Fire Escapes. *Steel*, Vol. 95, Dec. 31, 1934, page 25. In normal times, several thousand tons of bars, angles, and other steel products are used annually in the fabrication of fire-escapes. Outlines principal features. MS (14b)

5

Testing Hardened Tool Steels at the Fafnir Bearing Plant. WM. C. BETZ. *Modern Machine Shop*, Vol. 7, Mar. 1935, pages 26-34. Testing methods, apparatus and heat treatment processes for obtaining proper hardness in C tool steels are described. The following hardnesses are recommended for good service of tools:

Purpose	Rockwell	Scleroscope
Piercing and blanking dies	C59-62	84-90
Piercing punches	C57-59	80-84
Plug, ring and pad gages	C64-67	96-102
Reamers and broaches	C61-63	87-92
Taps	C60-62	85-89
Forming dies	C64-67	96-102
Forming punches	C62-65	89-97
Springs of all kinds	C45-48	57-61
Wood-working gages	C47-52	60-67
Burnishing broaches	C65-67	97-102

Ha (14b)

6

7

Steel Telegraph and Transmission Line Poles. *Engineer*, Vol. 158, Oct. 19, 1934, page 394. Tests were made in England by the Department of Scientific and Industrial Research on poles manufactured in Germany. The poles are made from steel sheets called "Patina-stahl." Tests showed that sheet steel poles will withstand an excess load appreciably above the specified safety factor of 2½ times the normal working load. LFM (14b)

8

Steel Building Without Joists, Studs or Rafters. *Iron Age*, Vol. 134, Aug. 9, 1934, page 29. Brief description of an insulated, fire-safe, steel farm building built at the Century of Progress for the American Milk Goat Record Association by the Steelox Co. in cooperation with the American Rolling Mill Co. It shows a new type of interlocking, self-framing system of construction. Use of rafters, studs and joists is eliminated. VSP (14b)

Seawalls of Sheet Steel Piling Guard Coast Highway. R. C. MEYERS. *Steel*, Vol. 95, Dec. 10, 1934, pages 34-35. From *California Highways and Public Works*. Describes construction. Piling was given protective asphaltic coating over quick drying prime coat. To protect against erosive action at scour line, fast drying primer was used, fairly hot air-blown asphalt was then applied, and slightly damp beach sand thrown against the asphalt. MS (14b)

9

The Manufacture of Files. F. MERCER. *Horological Journal*, Vol. 77, Jan. 1935, pages 136-141. A review is given of the oldest, yet most up to date factory for making files and watchmakers tools in England. The establishment is that of Stubs of Warrington which has operated in this industry since 1773. Files were originally hardened by quenching in beer dregs. Hand cutters are now employed as formerly, with female hands predominating. After shape of file blank has been formed by forging and filing the cutting is done by striking a fine edged chisel with a hammer while the file blank reposes on a bed of soft metal. Skill is the only control of regular sequence and depth of each cut. When cut the file is straightened and hardened, heat treating being controlled by eye. Grinders and sandblast used for even edge and cleaning. Machine process for file manufacture in this same plant is not discussed by the author. The hand process turns out precision-type file which commands a high price. WB (14b)

10

Using the New Steels. A. E. GIBSON. *Welding Engineer*, Vol. 20, Mar. 1935, pages 15-17. Economical advantages of making use of the improved physical properties of the new low alloyed steels are pointed out. Ha (14b)

Use of Alloy Steel Increases. *Blast Furnace & Steel Plant*, Vol. 23, Jan. 1935, pages 36, 65. Review of progress in 1934. Includes stainless steel flatware and hollow-ware; use of high-tensile low-alloy steels by railroads; 4-7% Cr steels for moderately high temperature service, and addition of Ti to such steels to reduce their tendency to air harden and to increase oxidation resistance; increased use of high-Cr steel castings through addition of N for refining grain, increasing impact strength, and reducing tendency toward excessive grain growth; development of high-Cr cast-Fe; and special ferrochrome for ladle additions of Cr to cast Fe. MS (14b)

1935 Dodge Has Semi-Elliptic Front Springs. *Automotive Industries*, Vol. 71, Dec. 22, 1934, pages 764-766. Soft front springs made of a new alloy known as Mola steel have a remarkably low spring rate for the length of spring used—115 lbs./in. of deflection at the wheels. A high factor of safety is maintained, although spring stresses are increased due to a much higher tensile strength of the new alloy than that of the usual spring metal. All leaves are ground before heat treatment, to remove any surface nicks or cracks that might result in fatigue failure. BWG (14b)

Cromansil Steel Used in Hull Construction of America's Cup Defender. *Iron Age*, Vol. 134, Oct. 25, 1934, page 43. Describes the construction of the Rainbow by the Herreshoff Mfg. Co., Bristol, R. I. By use of cromansil high strength without excessive weight was obtained. The composition of cromansil is Cr 0.4 to 0.6%; Mn 0.9 to 1.4%; and Si 0.6 to 0.9%, developed by Electro Metallurgical Co., New York. Gives table comparing its physical properties with those of other metals. VSP (14b)

Protection against Fire in Ships (La Défense Contre l'Incendie dans la Construction Navale). G. Bricard. *La Revue Industrielle*, Vol. 65, Jan. 1935, pages 21-28. Material advocated for partitions is as follows: steel plate of 6 mm. thickness, then an air layer of 25 mm. thickness, then a layer of slag wool of 50 mm. thickness, last a layer of wood 9 mm. thick. FR (14b)

Steel Construction for Small Residences (Die Stahlbauweise für den Kleinwohnungs- und Siedlungsbau). *Montanistische Rundschau*, Vol. 27, Feb. 16, 1935 (section *Stahlbau-Technik*) page 8. Abstract of a paper presented by R. Batz at a recent meeting of V. D. I. (Society of German Engineers) in Essen. Twenty steel houses in Düsseldorf-Golzheim have been given a thorough test to determine their usefulness. These houses are built of steel plates with proper heat insulation. Compared with houses of standard construction it has been found that the steel houses are in no way inferior. They are easy to erect and cheap in construction. BHS (14b)

Metals for Gyroscope Rotors. Edwin F. Cone. *Iron Age*, Vol. 134, Aug. 30, 1934 pages 14-19. There are four classes of materials used for rotors: plain C and alloy steels, Mn bronze and brass. Uniformity of the metal is of greatest importance since a slight variation affects the equilibrium of the rotor. Some idea on amount of metal used in making a steel rotor may be had for the 13 ft. rotors for the Conte di Savoia. Total wt. 256,500 lb.; net wt. of finished half section 102,000 lb.; net loss of metal for both sections 295,000 lb. Gives the compositions and properties of metals used for rotors. VSP (14b)

Street Railway Cuts Costs by Using New 4½-Inch Girder Rail. Edwin F. Cone. *Steel*, Vol. 95, Dec. 31, 1934, page 18. In rolling these new rails, it was found necessary to design rolls for 11 passes instead of 9, the number used in shaping standard 9″ and 7″ rails. They can be rolled on the same mill used in rolling all girder and standard T rails. Principal complications in producing the new section were in the detailed design of the individual passes. New rail makes possible drastic reduction in amount of excavation necessary in replacement, elimination of wooden tie replacement, and a saving in steel. MS (14b)

Helical Gears—Yesterday, Today and Tomorrow. P. C. Day. *Steel*, Vol. 96, Jan. 14, 1935, pages 25-27, 36. From a paper read before the American Gear Manufacturers Association. History of helical gears in the United States and critical appraisal of modern gears, bearings, lubricants, couplings, and related equipment. Pays some attention to materials. For many years practically all gear frames and cases were made from gray Fe castings. Tendency in recent years has been to substitute first steel castings and then a combination of castings and welded plates. For most applications cast Fe is perfectly satisfactory. In some cases, welded construction was specified where cast-steel gears would have been better. MS (14b)

And Now the Light-Weight Street Car. Rogers A. Fiske. *Iron Age*, Vol. 134, Oct. 4, 1934, pages 18-20. Describes a street car constructed by Pullman Car & Mfg. Corpn. The structural members are made of pressings of Cor-ten steel. Gives dimensions of the car. Welding was used to improve outside appearance of car. Trucks are of special design to eliminate noise and weight. Heating, lighting and ventilating are improved. VSP (14b)

Use of Cast Iron in Certain Reinforced Concrete Constructions (Un Débouché pour la Fonte dans certains Constructions en Béton armé). L. J. Gouttier. *Revue de Fonderie Moderne*, Vol. 29, Jan. 10, 1935, pages 1-4. Several examples illustrate reinforcement of old cast iron bridges by casting concrete around the iron. This adapts them to the increased stresses of modern traffic. Ha (14b)

Laminated Sheets Give Sound Damping in Budd Steel Roof. Joseph Geschelin. *Automotive Industries*, Vol. 72, Feb. 9, 1935, pages 172-173. A description with diagrams is given of a number of automobile steel top designs. Preferred construction involves stamping the combination roof and back panel from special laminated sheet with spot welds along the leg of the channel section and joints filled with solder. The laminated sheet provides greater protection against drumming. No roof ribs are used and the headlining, a special felt fabric, can be cemented directly on the metal. BWG (14b)

Demountable Steel Containers for Transfer From Freight Car to Motor Truck. T. H. Gerken. *Iron Age*, Vol. 134, Dec. 6, 1934, pages 45-47, 78-79. Describes the latest type of all steel freight containers developed by the Motor Terminals Co. The company also has suggested a design for a flat car suitable for demountable bodies. VSP (14b)

15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

Application of Statistical Methods to the Solution of Metallurgical Problems in the Steel Plant. W. C. Chancellor. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, 1934, pages 891-909, discussion pages 910-919. In efforts directed toward the production of uniform steel quality, the desirability of considering plant metallurgical data on a statistical basis is emphasized, since the "exact relationships" governing are complex in their resultant effects and, hence, produce variable rather than "exact" results. The application of comparatively recent theory to the detection of assignable causes of variation is discussed and illustrated. Explanations of statistical principles involved are generally of a non-mathematical sort, the object being to stress the practical meaning and usefulness of the mathematical theory. The use of rational subgroups of data rather than individual values is stressed, since the former can be more accurately treated by present theory. Typical examples, involving the open-hearth and subsequent processes, are used to illustrate the value of statistical control charts in determining whether statistical control of quality exists or whether variation is affected by the presence of assignable causes. VVK (15)

Acceptance-Rejection Requirements in Specifications. H. F. Dodge. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, pages 877-890, discussion 910-919. The selection of a criterion of acceptance or rejection of product requires on the part of a specification-writing committee, among other things, a choice of the quality characteristics for which tests shall be made, a choice of the measure of quality to be used in judging satisfactoriness in respect to each characteristic, and a choice of the risks to be borne by the producer and the consumer when using the criterion as a basis for action. One kind of producer and consumer risk has been discussed, and for a given choice of the magnitude of risks of this kind, a method of determining sample size is indicated when either the average, or the fraction defective, is chosen as the measure of quality to be used in an acceptance requirement. VVK (15)

Automobile Industry's Recovery Was a Feature of 1934. Burnham Finney. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 87-90, 93-94. 1934 was a year of increased production of both passenger cars and trucks, of expanding plant capacity, of mounting expenditures for modernization of equipment and of transition of operating and sales organizations from an emergency depression basis to a more lasting and stable form. In the matter of materials, there has been a growing trend toward use of electric furnace cast alloy steel and Fe. Cast crankshaft was substituted for the forged product by Ford. Development of Mo steel has gone ahead. Many alloy steels and non-ferrous metals are being held back from adoption solely on the basis of price. Bearing materials such as Cu-Pb and Cd-Ag-Cu are being adopted by some manufacturers. Stamping practice is favoring the use of larger sheets. Welding art has attained new distinctions during the past year. Plant modernization and expansion of productive capacity were widespread. In the industrial relations field much progress was made. VSP (15)

Oil Industry Will Spend More for Steel and Equipment in 1935. George Ehrnstrom, Jr. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 112-114, 117-118. Oil refineries in an effort to produce better gasoline are using more elaborate distilling apparatus in which heat resisting steels and alloys have become increasingly important. Metallurgical research is being intensified on heat resisting metals for refinery service. A large amount of electric welded casing, tubing and line pipe has been used by the oil industry. A substantial increase in casing, tubing and line pipe demand is expected in 1935. Use of stainless steel and other alloys in the oil fields is increasing. Sucker rods are produced from straight C, C-Mn steels, wrought Fe and alloy combinations. Where high S oils, abrasion and corrosion present serious problems wrought Fe is used. Another development that has gained increased application is the calorizing of steel tubes. Prospects for steel and alloys in natural gas field are not so favorable. VSP (15)

Chromel & Alumel; Alloys for Thermocouples. W. A. Gatward. *Metal Progress*, Vol. 27, Mar. 1935, pages 31-35. Describes manufacturing variations which have in the past required considerable classification of melts in order to get couples of correct emf. This necessity is less with improved control of melting and more uniform raw materials. Precautions to be observed in use of couples are protection against reducing atmosphere and use of lead wire of same material as the couple elements. Recommendations of protection tube materials are made for various temperature conditions. Methods of testing and standardizing wire are described. WLC (15)

Indiana Harbor Plant of the Youngstown Sheet & Tube Company. Charles Longenecker. *Blast Furnace & Steel Plant*, Vol. 23, Jan. 1935, pages 46-58. Description of plant and its equipment. Includes 120 Semet-Solvay coke-ovens; 2 blast-furnaces of 700 and 900 tons capacity respectively; 3 140-ton and 4 260-ton open-hearth furnaces; 2 15-ton Bessemer converters; a 35″ reversing blooming-mill; a 21″ continuous billet mill; a 21″ continuous bar mill; a 10″ continuous skelp mill; a 10″ and a combination of 14″ and 18″ merchant mills; a 30″ universal plate-mill; 24 stands of hot black plate rolls; a reversing 4-high cold mill; 30 stands of 2-high cold rolls; 3 lap-weld and 2 butt-weld pipe units; and an 18″ merchant mill for tie-plates. MS (15)

Review of Iron and Steel Literature for 1934. E. H. McClelland. *Blast Furnace & Steel Plant*, Vol. 23, Jan. 1935, pages 59-61, 70; Feb. 1935, pages 132-133, 150-151; *Heat Treating & Forging*, Vol. 21, Jan. 1935, pages 31-34; Feb. 1935, pages 85-87. 18th annual classified list of the more important separately published books and pamphlets of the year, with a few of 1933 not available for inclusion in last year's list. Will be reprinted, with additions, by the Carnegie Library of Pittsburgh and may be obtained gratis. MS (15)

Plans for Coöperation of Science and Practice in Industry (Voraussetzungen für den Zusammenarbeit von Wissenschaft und Praxis im Betrieb). M. Rhaydt. *Zeitschrift für Metallkunde*, Vol. 26, Oct. 1934, pages 225-226. General. FNR (15)

Tungsten—Part 1. WILLIAM O. VANDERBURG. *United States Bureau of Mines, Information Circular* No. 6821, Jan. 1935, 30 pages. General, including uses of W and production of ferrotungsten, H_2WO_4, W powder, ductile W, and cemented W carbide. AHE (15)

Rare Metals Becoming More Common. PAUL M. TYLER & COLIN G. FINK. *Mining & Metallurgy*, Vol. 16, Jan. 1935, pages 9-11. Some of the outstanding developments in rare metal field were the discovery of element "93" by Enrico Fermi and a new element named Bohemium by its discoverer Odolen Kablic. In its natural state it is associated with Re ores. Niccolini suggests a scheme for sub-dividing the chemical elements with regards to their olfactosensibility. Special mention is made of the Electrochemical Society's symposium on rare metals. Progress in the development of the following metals during the past year is discussed: As, Ba, Gl, Bi, Cd, Ca, Cb, diamonds, Ga, In, Li, Mo, Hg and Ra. VSP (15)

Metallurgical Research. *Iron & Coal Trades Review*, Vol. 130, Feb. 8, 1935, page 253. The annual report of the (British) Department of Scientific and Industrial Research deals with creep and growth of cast Fe, light alloys, steel castings and alloy steels, and the oxidizing power of basic slags. Ha (15)

Zinc Developments in 1934. U. C. TAINTON. *Mining & Metallurgy*, Vol. 16, Jan. 1935, page 8. Continuation of low prices for Zn has militated against any changes in position of metal. One of the most significant events was the putting into operation of an electrolytic plant of Giesches Co., Madgeburg, Germany. In United States ratio of electrolytic to total Zn production declined. Sullivan Mining Co., announced that grade of its Zn is approaching the "five-nine figure." Product has been improved from 99.99% in 1928 to 99.998% at present. In England the National Smelting Co. is operating a plant for production of 99.99% Zn by process of redistillation and vertical retort smelting. Bethlehem Steel Co., increased production of Zn coated wire by an electrolytic process. Considerable progress has been made in use of Zn in sprayed metal coatings. VSP (15)

Vigorous Competition for New Markets Spurred Metallurgical Activity in 1934. T. W. LIPPERT. *Iron Age*, Vol. 135, Jan. 10, 1935, pages 16-23. Competitive pressure caused research metallurgists to develop materials and processes which overlap considerably. Although each material seems to enjoy some degree of acceptance, its ultimate commercial status will be in direct proportion to the ease in which it meets certain physical requirements or provides some special satisfaction. Major developments in low-alloy steels having good welding characteristics and corrosion resistance are: Cor-Ten, 0.50 to 1.50% Cr and Man-Ten a medium Mn steel of 1.25 to 1.75% Mn with 0.20% Cu minimum offered by the United States Steel Corpn., and Republic Steel Co's. R D S alloy, Cu 1.50% and Mo 0.20 to 0.30%. In the high alloy steels for use in apparatus for the synthesis of ammonia a W bearing steel of 2.85% W was developed. Improvements in stainless steels to combat corrosive action, moderate temperature and high pressure have been developed. Other noteworthy developments are: IngOclad a rustless steel developed by Ingersoll Steel Co., stainless-invar by Hakar Masumoto of Japan, Gl as an alloy, direct reduction of wrought Fe, a new Ce-Al alloy known as Ceralumin C developed in England, surface hardening of Al alloys, series of Cu-Zn alloys with Si addition, Tungum a Cu alloy which withstands salt water and a Se alloy of high thermoelectric power developed in Germany. Other developments are a B_6C used for grinding wheels, abrasive wheels and the like, developed by Norton Co., a new liquid carburizer known as Perliton of the E. F. Houghton & Co. and Chapmanizing process developed by Chapman Valve & Mfg. Co. VSP (15)

Sources of Ores of the Ferro Alloy Metals. ERNEST F. BURCHARD. *Journal of Chemical Education*, Vol. 10, June 1933, pages 359-368. Since all steel is made with the addition of alloying elements, the record of the metallic raw materials contributory to the steel industry should include reference to the ferro alloy metals. This paper deals with occurrence and properties of ores of the following metals: Al, Cr, Co, Cu, Mn, Mo, Ni, P, Si, Ti, W, V, Zr. GTM (15)

Radium Ores in France and in the World (Les Minerais de Radium en France et dans le Monde). V. CHARRIN. *La Revue Industrielle*, Vol. 65, Jan. 1935, pages 19-21. Gives history of radium production. It is explained that the Katanga deposits in the Belgian Congo are now the single source of the 60 g. of radium which are necessary for world consumption. 2 deposits are known in France one of which was worked out before the Katanga deposits were discovered. FR (15)

The Manufacture of Files. *Machinery*, London, Vol. 45, Nov. 29, 1934, pages 333-337. The line production methods for manufacturing British files of the J. J. Saville & Co., Ltd., are described. Continuous cutting, annealing and inspection. Steam scouring, sand blast sharpening, cleaning and lead bath tempering. WB (15)

Research for Industry. *Scientific American*, Vol. 152, Jan. 1935, page 30. A survey is made of Battelle Memorial Institute, the equipment with which projects are carried out shown in photographs. The conditions of undertaking research are outlined and specific commercial results of the research indicated. WB (15)

A Precision Optical Pyrometer. M. MILFORD, R. J. BRACEY, F. A. CUNNOLD & A. C. EGERTON. *Journal of Scientific Instruments*, Vol. 12, Mar. 1935, pages 80-84. A disappearing filament pyrometer of rigid construction for precision work is described, giving overall magnifications of 20 and 5 and provided with special monochromatic filters in the red and green and absorption screens for the measurement of very high temperatures. RAW (15)

New S.A.E. Steels. FRANK P. GILLIGAN. *Metal Progress*, Vol. 27, Apr. 1935, pages 57-60. Tabulates the compositions of 109 standard S.A.E. steels and discusses the utility of this standardization and its trends. WLC (15)

The Evolution of Design. C. D. GIBB. *Institution of Mechanical Engineers, Proceedings*, Vol. 127, Apr.-Nov. 1934, pages 361-367. Technical progress as due to development of materials, metallurgy, operating methods and design using correctly the materials and their properties as developed by resarch is discussed in a lecture before the Institute of Mechanical Engineers in New Castle upon Tyne. Ha (15)

Textbook of Inorganic Chemistry (Lehrbuch der anorganischen Chemie). E. H. RIESENFELD. S. Hirzel Verlag, Leipzig, 1934. Paper, 6¼ x 9¼ inches, 698 pages. Price 14 RM.

Some 350 pages of the book are devoted to metals and their compounds. A few equilibrium diagrams of metal systems are included and there are the usual few words that text books of inorganic chemistry usually devote to the properties of metals. Heat treatment of steel is dismissed in a dozen lines. A micrograph of ferrite shows many large slag inclusions without comment to keep the student from thinking it to be a two-phase system. The metallurgist will not find it of value, save for its content of information on inorganic compounds. H. W. Gillett (15)-B-

Use of Potentiometric Analyses (Ausführung potentiometrischer Analysen nebst Analysenvorschriften für technische Produkte). WERNER HILTNER. Julius Springer Verlag, Berlin, 1935. Paper, 6 x 9 inches, 141 pages. Price 6.60 RM.

The author in the first 43 pages gives a brief review of the theory underlying potentiometric titrations, and discusses various types of electrodes that are used for titrating different solutions. Illustrations are given to show typical titration curves, electrodes, and electrical set-ups. This section is followed by condensed outlines for determining various cations and anions. Methods for 30 single cations, 53 combinations of 2 or more cations, 27 single anions, and 13 for groups of 2 or more anions are included. The last sections of the book are devoted to more detailed analytical methods including dissolution of the sample and preparation of the solution for titration by potientiometric methods. Among the determinations described are those for steel, alloy steel, ores, ferro alloys, carbonate minerals, a number of non-ferrous alloys, sulphide ores and furnace products.

The work is concise and the kind of electrodes and solutions to use for various determinations are given. The book is recommended as a reference work for laboratories using potientiometric titrations or contemplating doing so.
John D. Sullivan (15)-B-

Transactions American Institute of Mining & Metallurgical Engineers, 1934. Iron & Steel Division, Vol. 113. Published by the Institute, New York, 1934. Cloth, 6¼ x 9¼ inches, 299 pages.

The papers in this volume have already been abstracted from preprints, but the cream of such a volume is in the discussions, which appear only in the bound volume. Besides Dr. Speller's Howe Memorial lecture on the corrosion problem, 17 papers are included, of which one relates to blast furnace operation, one to open-hearth practice, two to the effect of Ti and Cb in Cr and Cr Ni steels, one to deep-drawing, and the balance to determination of oxygen, to X-ray and other studies of transformations and age-hardening processes, and of diffusion. Modern physical metallurgy overshadows purely production problems in this particular volume. Not all the papers presented at the meeetings are published in the Transactions. Most of those selected for publication are of the type which are not readily grasped on oral presentation but require study. A foreign reader, noting the preponderance of "high-brow" papers, might get an odd idea of the general type of American metallurgical engineer. The answer is that the high-brows publish, the plant men seldom do. H. W. Gillett (15)-B-

Technical Applications of Physical Chemistry (Die technischen Anwendungen der physikalischen Chemie). J. HOLLUTA. Ferdinand Enke Verlag, Stuttgart, 1934. Paper, 6½ x 9¼ inches, 354 pages. Price 20 RM.

This is a discussion of principles of physical chemistry with illustrations often drawn from useful applications, among which smelting problems, those in physical metallurgy and ceramics appear quite frequently. The treatment is therefore broader than in most books on physical chemistry and of more interest and value to the metallurgist. H. W. Gillett (15)-B-

15a. Economic

Iron and Steel in 1933. J. H. THOMPSON. *Mining Journal, Annual Review No.*, Vol. 184, Feb. 17, 1934, page 18. The Fe and steel industry in Great Britain is discussed. AHE (15a)

Compiles Jobbing Shop Rate Date. R. A. RISLEY. *Foundry*, Vol. 62, Jan. 1934, pages 15, 41, 43. Discusses method used at the plant of Goslin-Birmingham Mfg. Co. for estimating molding costs. Explains how data is applied. Includes table for drag, cope and pattern values which shows the form in which standard data appears. VSP (15a)

Central Europe Nearing Its Turning Point. JAN TILLE. *Steel*, Vol. 94, Jan. 1, 1934, pages 173-174. Review of iron and steel industry in Czecho-Slovakia, Poland, Austria, and Hungary during 1933. MS (15a)

Russia (En Russie d'Europe et d'Asie.) E. A. ROUSSEAU. *Bulletin de l' Association Technique de Fonderie*, Vol. 8, Jan. 1934, pages 9-22. An account of a trip through European Russia and into Siberia. General conditions with special reference to iron and steel industries. WHS (15a)

World Survey of Lead Production and Resources. J. R. FINLAY. *Mining & Metallurgical Society of America Bulletin* 229, Vol. 27, Apr. 1934, pages 34-48. There is a steady drift of Pb production away from populous industrial countries that have in the past contributed more than 80% of the production. Future demand is estimated at 1,500,000 tons a year. AHE (15a)

Lead and Zinc in 1933. O. W. ROSKILL. *Mining Journal, Annual Review No.*, Vol. 184, Feb. 17, 1934, pages 14-15. World production of Zn in 1933 was about 996,000 metric tons (782,000 tons in 1932) and of Pb 1,164,000 tons (1,138,000 tons in 1932). AHE (15a)

Relation of Lead Substitutes to the Lead Industry. E. J. CORNISH. *Mining & Metallurgical Society of America Bulletin* 229, Vol. 27, Apr. 1934, pages 58-61. General. AHE (15a)

Gold in 1933. E. BALIOL SCOTT. *Mining Journal, Annual Review No.*, Vol. 184, Feb. 17, 1934, pages 1-2. Au production in 1933 is estimated at 23,819,219 oz., 191,952 less than in 1932. AHE (15a)

Possible Applications of Large Amounts of Cheap Hydro-electric Power to Mineral and Metal Production in the Pacific Northwest. A. E. DRUCKER & CARL F. FLOE. *State College of Washington, Mines Information Bureau, Information Circular* No. 3, Nov. 20, 1933, 10 pages. The utilization of electrical energy in production of Cu, Zn, Cd, Pb, Al, Mg, Be, fertilizers and nitrogenous compounds is discussed briefly. AHE (15a)

Mine Production of Gold, Silver, Copper, Lead, and Zinc in Washington in 1933, by Counties. C. N. Gerry. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 297, July 25, 1934, 1 page. Production of Au was 4,562.68 oz., Ag 18,520 oz., Cu 5,781 lbs., Pb 1,680,430 lbs., and Zn 6,738,169 lbs., a decrease in Au and Pb. The total value was $446,350, as compared with $300,263 in 1932. AHE (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in Utah in 1933, by Counties. C. N. Gerry. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 296, July 26, 1934, 1 page. Production of Au was 109,129.55 oz., Ag 5,669,197 oz., Cu 73,583,130 lbs., Pb 117,376,556 lbs., and Zn 59,489,193 lbs., a decrease in Au, Ag and Pb. The total value was $15,790,926 as compared with $14,398,593 in 1932. AHE (15a)

Ways to Obviate a Lack of Metallic Raw Materials (Auswege aus dem Mangel metallischer Rohstoffe). H. M. Forstner. *Oberflächentechnik*, Vol. 11, Aug. 7, 1934, pages 163-165. In discussing the possibilities of replacing or finding substitutes for essential raw materials in the metal industries from the specific German view point, more generally interesting data have been collected. As examples are given substituting Hg by Ga, more extended use of light metals in place of Cu and its alloys and further development of corrosion protective methods. Of the latter, processes for protecting Al and its alloys by the Eloxal process, coating or welding on heavy metals, or spraying on of heavy metals are discussed. Non-ferrous heavy metals are made corrosion proof by nickel-steel plating, anodic treatment in hot electrolytes, phosphate coating, galvanizing, electrolytic lead-plating, alumination by immersion and spraying, and electrolytic brass-, Cu and rare metal plating. The prevailing German conditions are discussed. Ha (15a)

Canadian Iron and Steel Industry. F. W. Field. *Iron & Coal Trades Review*, Vol. 129, Sept. 28, 1934, page 462. Conditions and statistics for 1933-1934 are discussed. Ha (15a)

Summary of Mineral Production. M. B. Clark & E. T. Shuey. *United States Bureau of Mines, Statistical Appendix to Minerals Yearbook*, 1932-33, pages A1-A40. Final figures are given for mineral production by states, showing each state's output of different minerals. AHE (15a)

Gold and Silver. J. P. Dunlop. *United States Bureau of Mines Statistical Appendix to Minerals Yearbook*, 1932-33, pages 455-479. Au production in 1932 increased 1,098,800 oz. to 2,449,032 oz. Ag output declined 6,951,277 oz. to 23,980,773 oz. World production was $499,048,746, an increase of $37,456,500 over 1931. AHE (15a)

Economic Possibilities for Electrometallurgical Industries Within the State of Washington and the Pacific Northwest. Some Economic Considerations for the Successful Development of These Industries. A. E. Drucker & Carl F. Floe. *State College of Washington, School of Mines and Geology, Mines Information Bureau, Information Circular* No. 4, Dec. 1933, 17 pages. The electrical energy requirements of electrometallurgical products, the cost of electric power in the major electrometallurgical industries, and the production and utilization of the major electrometallurgical products are presented. AHE (15a)

Platinum and Allied Metals in 1933—Advance Summary. H. W. Davis. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 298, Aug. 2, 1934, 5 pages. Domestic mine production of Pt in 1933 was 1,266 oz. (1,074 oz. in 1932),—793 oz. from Alaska, 417 oz. from Calif. and 56 oz. from Ore. Pt refiners in the U. S. purchased 58,897 oz. of foreign crude Pt (19,043 oz. in 1932),—12 oz. from Canada, 54,784 oz. from Columbia, and 4,101, oz. from S. Africa. Recovery of refined Pt metals increased 193% to 51,530 oz.,—48,581 oz. Pt, 942 oz. Pd, 1,434 oz. Ir, 492 oz. osmiridium, and others 90 oz. AHE (15a)

Zinc Dust Consumption at Canadian Gold Mines (1931-32-33). A. Buisson. *Canada Department of Mines, Mines Branch, Memorandum Series* No. 61, May 1934, 6 pages. In 1933 Canada used approximately 556,600 lbs. of Zn dust in the precipitation of Au in the cyanide process. Domestic production supplies about 40% of this demand. AHE (15a)

The American Detinning Industry. *Tin*, June 1934, pages 5-7. Conditions and extent of separation and recovery by chemical processes of tinplate scrap, i.e. tin and steel, is reviewed from a report to U. S. A. House Committee on Military Affairs. Approximately 8.65% of the total tin consumption were covered by detinning and refining. Ha (15a)

Secondary Tin. *Tin*, Feb. 1935, pages 4-5. The volume of secondary tin production is shown to be primarily dependent upon the activities and production of the tin plate mills or upon the amount of primary tin used. A higher primary tin price does not appreciably stimulate production of secondary tin. BWG (15a)

Tin Consumption Analysis. *Tin*, Jan. 1935, pages 20-21. Although the world's "apparent" consumption of tin shows a decrease of 8.1% in the year ending Oct. 1934 the actual world consumption in manufacture increased 3.2%. The "apparent" tin consumption in the U. S. for the same period shows a decrease of 26.2% although the actual amount used was about the same as in the previous year. Tin used in bearing metals in the U. S. increased by 13½%, in solder by 36%. BWG (15a)

The Iron and Steel Industry in Germany. J. W. F. Thelwall. *Iron & Coal Trades Review*, Vol. 129, Aug. 10, 1934, page 189. Report No. 582 to the (British) Department of Overseas Trades on economic conditions in Germany and in particular on production, values, export trade and reorganization developments in 1933 in the steel industry. Ha (15a)

French Iron and Steel Industry in 1934. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, pages 87-88. Review. Ha (15a)

The Light Alloys in Industry and Engineering. G. Eckert. *Engineering Progress*, Vol. 16, Feb. 1935, pages 56-57. Usefulness and fields of application are described; a table of 11 of the most used Al and Mg alloys with physical properties (metric and English units) is added. Ha (15a)

Consumption of Alloy Steel Is More Diversified in 1934. *Steel*, Vol. 96, Jan. 7, 1935, pages 115-116. Reviews status of alloy steel industry in the United States and major developments in 1934, with chief attention to low-alloy high-tensile and stainless steels. Tabulates percentage of consumption by groups and by products for 1928-1934, and percentage of distribution of individual products to consuming groups in 1934. Consumption by groups in 1934 was automotive, 53.31%; machine-tool, 4.88%; oil industry, 1.52%; agricultural, 2.42%; construction, 1.55%; exports, 0.58%; railroads, 4.11%; shipbuilding, 1.21%; and miscellaneous, 30.42%. MS (15a)

Metal Mining in Utah, 1934—Advance Summary. C. N. Gerry & T. H. Miller. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 335, Jan. 7, 1935, 3 pages. Au output in Utah in 1934 increased from 109,129.55 to about 134,100 oz., Ag from 5,669,197 to 6,985,000 oz., and Cu from 73,583,130 to 85,585,000 lbs. (16%). Pb production decreased from 117,376,556 to 111,871,000 lbs. and Zn from 59,489,193 to 56,220,000 lbs. AHE (15a)

Metal Mining in Idaho, 1934—Advance Summary. C. N. Gerry & T. H. Miller. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 331, Jan. 5, 1935, 2 pages. Au output in Id. in 1934 increased about 34% to 86,600 oz. Ag production increased from 6,987,960 to 7,310,000 oz. worth $4,722,260. Cu output decreased from 1,562,234 to 1,530,000 lbs. but increased in value. Pb production decreased about 3% to 148,726,701 lbs. Zn increased from 41,935,977 to 50,450,000 lbs. Total value increased 34.04%. AHE (15a)

Metal Mining in Arizona, 1934—Advance Summary. C. N. Gerry & Paul Luff. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 334, Jan. 7, 1935, 3 pages. Au output in Arizona in 1934 increased 96% from 1933 to 157,000 oz., Ag from 2,390,363 to 4,150,000 oz., Cu from 114,041,781 to 178,200,000 lbs., Pb from 3,442,540 to 5,800,000 lbs. and Zn production was resumed. AHE (15a)

Metal Mining in Washington, 1934—Advance Summary. C. N. Gerry & Paul Luff. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 332, Jan. 5, 1935, 2 pages. Au production increased from 4.562.68 oz. in 1933 to about 6900 oz. in 1934. Ag output increased from 18,520 to about 40,000 oz. Cu production was about the same both yrs., 5781 lbs. Pb output decreased from 1,680,430 to 630,000 lbs. Zn production decreased from 6,738,169 to 3,800,000 lbs. AHE (15a)

Mine Production of Gold and Silver in 1933—Advance Summary. J. P. Dunlop. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 325, Dec. 13, 1934, 4 pp. Mine production of Au in the U. S. in 1933 was 2,628,775.36 oz., an increase of 54,351 oz.; Ag output was 23,317,159 oz., a gain of 417,294 oz. AHE (15a)

The Spanish Coal, Iron and Steel Industries. L. Barreiro. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, page 92. Review of production of ores, pig Fe and steel, and economic conditions. IIa (15a)

Outlook for the Electric Melting Furnace for the German Aluminum Production (Aussichten des elektrischen Schmelzofens für die deutsche Aluminiumverarbeitung). *Elektrowärme*, Vol. 4, Dec. 1934, pages 281-282. A calculation of the possible development of induction furnaces, power consumption and generation of electric energy in private and public works is made on the basis of a consumption of 350 kw.hr. for melting 1 ton Al, for a total yearly production of 50,000 tons. Ha (15a)

The Belgian Iron and Steel Industry in 1934. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, pages 88-89. Review. Ha (15a)

The World's Metal Production and Consumption. *Engineer*, Vol. 158, Aug. 17, 1934, page 165. From the annual report of the Metall Gesellschaft, Frankfurt-am-Main. The following figures are quoted:

World's Production in Thousands of Metric Tons

	1933	1932	1929
Pb	1148.8	1148.5	1742.2
Cu	1049.7	929.0	1894.7
Zn	986.5	781.5	1457.3
Sn	100.1	106.0	195.0
Al	141.5	153.5	276.8

World's Consumption in Thousands of Metric Tons

	1933	1932	1929
Pb	1207.2	1093.3	1699.9
Cu	1068.0	902.2	1761.9
Zn	1006.0	827.5	1439.8
Sn	144.8	114.7	183.8
Al	162.0	141.3	276.0

LFM (15a)

The French Tin Industry. *Tin*, Sept. 1934, pages 18-21. Report to the (British) Department of Oversea Trade deals with organization, production, imports and exports, and trade conditions. Ha (15a)

Tin Production in China and Indo-China. *Tin*, Aug. 1934, pages 19-20. A discussion of the location of mines, general mining difficulties and the companies engaged in mining tin in the chief producing areas of Yunnan, Laos and Tonkin. BWG (15a)

The Foundry Industry in the Organization of German Economics (Die Giessereiindustrie in der Organisation der deutschen Wirtschaft). J. Schmauser. *Die Giesserei*, Vol. 21, Sept. 28, 1934, pages 405-408. Situation, importance and organization of German foundry industries, and their influence on production, marketing and industrial sociological problems in the German economic national life are discussed. Ha (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in Arizona in 1933, by Counties. C. N. Gerry & T. H. Miller. *United States Bureau of Mines, Mineral Market Reports*, No. M. M. S. 318, Nov. 14, 1934, 1 page. The total value of Au, Ag, Cu, Pb, and Zn produced in Ariz. in 1933 was $9,916,732, as compared with $13,533,935 in 1932. Au increased from 66,789.67 to 79,992.61 oz., Ag from 2,082,823 to 2,390,363 oz., Pb from 2,364,300 to 3,442,540 lbs., and Zn from 0 to 11,024 lbs. Cu declined from 182,491,825 to 114,041,781 lbs. AHE (15a)

Secondary Metals in 1933—Advance Summary. J. P. Dunlop. *United States Bureau of Mines, Mineral Market Reports*, No. M. M. S. 308, Sept. 11, 1934, 1 page. The value of nonferrous metals recovered from secondary sources, as reported to the Bureau of Mines was $101,268,000 in 1933, an increase of $36,246,000 over 1932. Recovery of each metal increased. AHE (15a)

Annual Report of the Quebec Bureau of Mines for the Calendar Year 1933, Part A, 1934, 175 pages. Statistics of metal production in Quebec in 1933 are given. AHE (15a)

Raw Material Problem in German Metallurgical Industry (Problem der Rohstoffversorgung in der deutschen Metallindustrie). F. SEEHOF. *Die Metallbörse*, Vol. 24, July 28, 1934, pages 954-955; Aug. 4, 1934, pages 987-988. Discusses the replacing of Fe and steel by non-ferrous materials. Emphasis is placed on Silumin, a 12-13% Si-bearing Al alloy. The former difficulties in regard to unsoundness, coarse grain, inferior physicals of sand and chill castings were eliminated by the invention of Pacz (U.S.A.) who adds .08% and .04% Na to respectively sand and chill cast silumin. Cu raises strength and workability. Silumin-β and γ contain Mg and Mn which were also found to improve the properties of Al alloys low in Si. Age hardening is possible.

Material	tensile strength in kg./cm.²	Brinell	elongation %	endurance bending strength kg./cm.²
Silumin-β chill cast	22-27	70-80	2-4	9-11
Silumin-γ chill cast	25-29	80-105	1-3	10-11
Silumin-γ age-hardened	28-33	90-115	1-3	11-12

Casting properties, physicals and utilization of Silumin are dealt with and corrosion resistance of Al and its alloys is discussed. The detrimental effect of alkalies on the latter is checked by water-glass. Sn foil is steadily being replaced by Al foil which is rolled from 40-60 kg. ingots at 500° and then cold rolled to .5 mm. strips. After an intermediary annealing, rolling into 5/1000-20/1000 mm. foil is carried out. Al-alloy analyses are given. Attention is called to successful experiments on bearing shells made of artificial resins. Testing results are given. EF (15a)

Antimony in 1933—Advance Summary. F. M. SHORE. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 313, Sept. 19, 1934, 1 page. In 1933, 1,133 tons of Sb ore and concentrates (587 tons Sb), 927 tons of Sb in antimonial Pb and 7,400 tons of secondary Sb were produced domestically, the first and last being increases. Imports increased and stocks decreased. AHE (15a)

Steel Production in the Empire Overseas. *Engineering*, Vol. 138, Aug. 3, 1934, pages 122-123. Editorial commenting on remarks made by W. R. Lysaght before the Iron and Steel Institute. LFM (15a)

Production and Market of Tin (La Production et le Marché de l'Étain) LEGRAVE. *Revue Universelle des Mines*, Series 8, Vol. 10, Aug. 1, 1934, pages 412-415. Deposits, world production, and methods of mining are reviewed and conditions in the various producing countries discussed. Ha (15a)

Tin Mining in Banka (De Tinwinning in Banka). L. LEGER. *De Ingenieur*, Vol. 49, June 1, 1934, pages M23-M31. Geological conditions, mining and smelter methods, statistical data on production since 1717 in the Dutch East Indian island of Banka. The total production since 1717 up to 1933 incl. was 951,600,000 kg., production in 1933 was 8,060,000 kg. Ha (15a)

The Luxemburg Iron Industry. A. KIPGEN. *Iron & Coal Trades Review*, Vol. 129, Sept. 21, 1934, pages 421-423. Development and present constitution are described, statistics from 1930 to now are given. Ha (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in Nevada in 1933, by Counties. F. W. HORTON. *United States Bureau of Mines, Mineral Market Reports*, No. M. M. S. 306, Aug. 24, 1934, 1 page. Total value in 1933 was $4,970,374, as contrasted with $5,067,171 in 1932. Output (quantity) of Au, Ag, and Cu declined. Pb and Zn increased greatly, Pb from 880,986 to 4,606,732 lbs. and Zn from 254,795 to 12,774,550 lbs. AHE (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in California in 1933, by Counties. F. W. HORTON. *United States Bureau of Mines, Mineral Market Reports*, No. M. M. S. 316A, Oct. 3, 1934, 4 pages. In 1933, Calif. produced Au 613,578.85 oz., Ag 402,591 oz., Cu 990,380 lbs., Pb 761,156 lbs. and Zn 290,214 lbs., total value $12,928,444, an increase from $12,066,750. Au production increased, all others decreased. AHE (15a)

Copper Slag as Paving Material (Kleinpflaster aus Kupferschlacke) für Fahrbahnbefestigung). A. HELLMUTH. *Verkehrstechnik*, Vol. 15, May 23, 1934, pages 266-269. Summarizes utilization of and practical experience gained on street pavements incorporating Cu slag paving stones. Cost sheets included reveal that this metallurgical by-product offers economical possibilities with reference to German conditions. WH (15a)

Indian Iron and Steel Production Costs. *Iron & Coal Trades Review*, Vol. 129, July 27, 1934, pages 120-121. The report of the Indian Tariff Board contains data on production costs, works costs and general costs of the Tata Iron Works for different kind of products. Ha (15a)

The French Iron and Steel Industries. *Iron & Coal Trades Review*, Vol. 129, Aug. 3, 1934, page 163; Aug. 10, 1934, page 198. A review of developments in recent years in pig iron and steel production and organization of the industry. Ha (15a)

Steel Plans and Problems. *Engineer*, Vol. 157, June 29, 1934, page 657. Editorial commenting on troubles arising in steel industry over reorganization plans, high duties, and the part the Government plays in these schemes. LFM (15a)

The Steel Trade's Future. *Engineer*, Vol. 158, Aug. 10, 1934, page 139. Editorial commenting on difficulties facing the iron and steel industry in coming to an agreement on quotas and duties. LFM (15a)

Quality Control of Products Manufactured by Mass Production Methods (Prüfung der Einheitlichkeit eines Massenfabrikates). FR. A. WILLERS. *Zeitschrift für angewandte Mathematik & Mechanik*, Vol. 14, Apr. 1934. pages 77-84 Mathematical treatment of the problem with emphasis on the question whether or not divergencies between the products from 2 different fabrication series are due to fundamental or accidental deviations from the standard production method. WH (15a)

Nickel in 1933—Advance Summary. C. E. JULIHN. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 312, Sept. 17, 1934, 1 page. The world output of Ni in 1933 was about 49,000 tons of which the U. S. produced 126 tons as a by-product of Cu refining. It also recovered 1650 tons of secondary Ni and imported about 19,000 tons. AHE (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in Idaho in 1933, by Counties. C. N. GERRY & T. H. MILLER. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 317, Sept. 24, 1934, 1 page. The 1933 output in Idaho was Au 64,592.23 oz., Ag 6,987,960 oz., Cu 1,562,234 lbs., Pb 148,726,701 lbs. and Zn 41,935,977 lbs., worth $11,145,208 ($7,877,604 in 1932). All are increases. AHE (15a)

Production of Gold, Silver, Copper, Lead, and Zinc in Montana in 1933, by Counties. C. N. GERRY. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 307, Aug. 28, 1934, 1 page. Quantity of Au, Ag, Pb and Zn produced in Montana in 1933 increased considerably over 1932, Zn increasing from 4,393,034 to 41,448,905 lbs. Cu output declined. Total value increased from $6,856,737 to $8,344,925. AHE (15a)

High-Spot Automotive Statistics. *Automotive Industries*, Vol. 72, Feb. 23, 1935, page 231. The total output of various materials bought by the automotive industry (presumably in 1934) was 23% of the steel and iron produced, 19% of the Cu, 39% of the Pb, 23% of the Al and 28% of the Ni. BWG (15a)

1

Steel Production in World in 1934 Again Overtakes 1913. VINCENT DELPORT. *Steel*, Vol. 96, Jan. 7, 1935, pages 141, 145. Tabulates per capita production of pig-iron and steel ingots and castings in United States, 1880, 1890, 1900, 1910-1934; production of pig-iron and steel ingots and castings in the different countries of the world, 1913, 1926-1934; and exports and imports of the principal countries, 1913, 1931-1934. In 1934, production of steel and pig-iron respectively in gross tons was United States, 25,953,000 and 16,057,000; Germany, 11,825,000 and 8,650,000; Russia, 9,250,000 and 10,000,000; Great Britain, 9,000,000 and 6,000,000; France, 6,050,000 and 6,050,000; Japan, 3,000,000 and 2,250,000, and Belgium, 2,895,000 and 2,865,000. World production was 79,778,000 gross tons of steel ingots and castings and 61,132,000 gross tons of pig-iron. MS (15a)

2

New Year May Bring Improvement in European Conditions. VINCENT DELPORT. *Steel*, Vol. 96, Jan. 7, 1935, pages 213-214. Brief review of European steel industry in 1934. MS (15a)

Production and Consumption of Lead in Germany (Gewinnung und Bewirtschaftung des Bleis in Deutschland). O. EISENTRAUT. *Zeitschrift für Metallkunde*, Vol. 26, Dec. 1934, pages 280-284. A comprehensive survey of the Pb supply in Germany, including: the development of the industry, sources of supply, production statistics and consumption. FNR (15a)

3

Recent Research in the Machine Tool Field. F. EISELE. *Engineering Progress*, Vol. 16, Jan. 1935, pages 1-5. Research in the machine tool field with the object of supplying the user with information enabling him to employ a machine to best advantage, and to give him data to decide on best possible design and construction of machine and tooling equipment, is reviewed. Materials and special alloys for tools and testing methods for them are discussed and testing machines described. 9 references. Ha (15a)

4

Political Uncertainties in France Hinder Steel Trade. LEON JAUDOIN. *Steel*, Vol. 96, Jan. 7, 1935, pages 217-218. Review of conditions in the iron and steel industry during 1934. Tabulates statistics on average monthly production, imports, and exports for 1913, 1931-Oct. 1934. Production in 1934 decreased as compared with 1933. MS (15a)

Year of Steady Progress for Steel Made in Great Britain. J. A. HORTON. *Steel*, Vol. 96, Jan. 7, 1935, pages 215-216, 258. Reviews conditions in the iron and steel industry during 1933. Gives statistics on average monthly production, imports, and exports for 1913, 1931-Oct. 1934. MS (15a)

5

Heavier Production, Higher Prices Revive Confidence in Steel Industry. A. J. HAIN. *Steel*, Vol. 96, Jan. 7, 1935, pages 179-181. Review of 1934 American market situation. MS (15a)

Rustless Steel Production Approaches Peak Level. T. W. LIPPERT. *Iron Age*, Vol. 135, Jan. 31, 1935, pages 27-29. A statistical survey of corrosion and heat-resisting steels from 1929-1934. In 1934 total output of such alloys was 43,695 tons, compared with 54,949 tons in peak year of 1930. Although tonnage is only a small % of total alloy steel output, the financial return is larger than for an equal tonnage of low-alloy steels. Includes tables giving the production of rustless steels in U. S., 1929-1934 and production of rustless steel in 1933 and 1934 by product and analysis. VSP (15a)

6

United States, Purveyor of Scrap to the World. T. W. LIPPERT. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 135-138, 141-142. Objections to foreign exportation of scrap are based on: (1) That the scrap is being converted into war materials; (2) That the basic resources of the country are being drained; and (3) That American mills in the near future may be faced with a dangerous shortage of scrap. Exportation of 2⅓ million tons of scrap in the past 2 years has exerted a noticeable influence on the position and price of scrap in this country. Cheap scrap for domestic mills is not now available, and there is a possibility that sudden heavy demands might result in an apparent shortage. Gives a table showing annual steel production and scrap imports of buyers from U. S. 1913-1934. VSP (15a)

7

Zirconium. A. LIKHACHEV & E. KOSTYLEVA. *Rare Metals*, Vol. 3, No. 1, 1935, pages 43-48. In Russian. No appreciable deposits of Zr were found in Russia. (15a)

8

Steel Industry Completes a 37 Per Cent Year. G. L. LACHER. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 189-192, 195, 198. Steel production in 1934 showed a gain of 12% over 1933. Earnings in second year of code are also disappointing. Total ingot production for last year, including electric and crucible steel, was about 25,625,000 tons, compared with 22,894,286 tons in 1933. Operations under the new deal had two upward surges, one in summer of 1933 and another in spring of 1934. Neither of them brought production rate above 60% of capacity and both were followed by sharp reactions. Pig Fe production for 1934 was estimated at 15,850,000 tons. Strikes as well as repeated wage advances have had a profound influence on steel production. Iron and steel prices failed to keep pace with wages. VSP (15a)

9

A New Old Industry Looms On the Horizon. G. L. LACHER. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 149-150, 153, 279. Stresses the re-equipment of the railroads, not alone with new types of freight cars, but also improved passenger cars and better motive power. This would increase operation of steel mills and makers of other materials and equipment. Developments in connection with material for freight equipment have not been limited to new alloys. Material of larger dimensions is now being rolled. To meet specifications for freight car roofs sheets of 30 ft. length and more than 8 ft. width are required. Trend toward increased use of alloys in motor buses is shown. Includes a list of miscellaneous applications of high tensile steels in transportation field, also a list of light weight railroad equipment completed or ordered in 1934. VSP (15a)

10

Bell Industries in England and America (L'Industrie des Cloches en Angleterre et en Amérique). J. R. NICHOLS. *Revue de Fonderie Moderne*, Vol. 29, Jan. 25, 1935, pages 23-26. The special art of bell casting, materials used, molding and pouring methods, and procedures of tuning are described. IIa (15a)

Steel Producers Win New Markets For 1935. F. L. PRENTISS. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 45-48, 51-54, 248, 250-256. Discusses the development of new products designed to be more suitable for specific applications than steels heretofore produced. Newly introduced ferrous materials were not numerous but were conspicuous and showed a trend towards production of steel with improved physical properties. Attention has been paid to development of abrasion resistant steel and special steels for corrosion and heat resistance. In list of new products made of steel and other metals consumer goods led. One of the most active fields was the kitchen equipment industry. In rolled steel products one of the most important developments was new grades of low-alloy high-tensile steels for use where lightness is desirable without decrease in strength and where increased corrosion resistance is desirable. In commercial and residence building field new formed steel products were brought out. New applications for stainless steel are constantly appearing. Field of rolled steel is gaining through adoption of built up structural members and stamped steel parts fabricated by welding. VSP (15a)

Modern Metals and Alloys (Les Métaux et Alliages Modernes). A. PORTEVIN. *Usine*, Vol. 44, Feb. 7, 1935, pages 25-27. Present metals and alloys used in industrial manufacturing processes and developed to increase economy in manual labor, time and efficiency, are reviewed. IIa (15a)

Russian Copper. II. GUY C. RIDDELL & G. D. JERMAIN. *Engineering & Mining Journal*, Vol. 136, Mar. 1935, pages 82-87. Cu districts of Soviet Russia are reviewed and the conclusion made that Russia will continue to be an importer of Cu on a large scale for a long time to come. WHB (15a)

Future Viewed with Optimism By the Iron and Steel Industry. L. F. REINARTZ. *Mining & Metallurgy*, Vol. 16, Jan. 1935, pages 37-43. Steel industry has been harassed by uncertainty of government's attitude towards labor's demand and irregularity in production. Plants producing steel for heavy durable goods industry have not enjoyed appreciable improvements. Mechanical development in sheet steel industry is progressing rapidly. Construction of steel houses has greatly increased. Enamelware and stainless steel vie for supremacy in domestic use. Despite many obstacles the steel industry is on its way out of the depression. Following brief reviews relating the Fe and steel industry are included: "Work progressing on iron-ore concentration" by P. Barrett; "Some concepts that are helping metallurgists to make better steel" by S. Epstein and J. H. Nead; "Literature on alloy steels indicates varied field of activity" by Jerome Strauss; and "Casting on metal molds without producing chill is developed" by J. T. MacKenzie. VSP (15a)

Advocates Revolutionary Changes in Steel-making Process. CHARLES F. RAMSEYER. *Iron Age*, Vol. 134, Nov. 22, 1934, pages 26-30. From a paper appearing in the Oct. 1934 issue of *Metals Technology*. See "A Chemical Engineer Views the Steel Industry," *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 82. VSP (15a)

Italian Steel Industry Is Being Further Organized. GUIDO VANZETTI. *Steel*, Vol. 96, Jan. 7, 1935, pages 220-221. Review of conditions in iron and steel industry during 1934. MS (15a)

Metal-Working Costs Under the New Deal. JOHN H. VAN DEVENTER. *Iron Age*, Vol. 135, Jan. 10, 1935, pages 10-12. Gives a graphical representation of a survey made by the Iron Age based upon the operating record, by quarters, of 111 concerns. The period begins with 2nd quarter of 1933 and ends with the 3rd quarter of 1934. VSP (15a)

Preliminary Data of the Work of Tungsten Department In Rare Metals Works in 1933. P. TOCHENY. *Rare Metals*, Vol. 3, No. 1, 1935, pages 27-30. (In Russian). Total production for Russia in 1933 was 186 tons of W. Extraction from domestic concentrates varied between 33 and 59%, though better results were obtained with imported concentrates. (15a)

Central Europe Emerging from Effects of Depression. JAN TILLE. *Steel*, Vol. 96, Jan. 7, 1935, pages 218-219. Reviews conditions during 1934 in the iron and steel industry of Czecho-Slovakia, Austria, Hungary, Poland, and Russia. MS (15a)

Iron and Steel Scrap in 1934. JOSEPH WARD. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, page 82. Review of consumption, import, export. IIa (15a)

Metal Mining in Montana, 1934—Advance Summary. T. H. MILLER & PAUL LUPP. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 336, Jan. 7, 1935, 3 pages. Au output in Montana in 1934 increased from 57,822.20 oz. to about 92,500 oz., Ag from 2,660,700 to 3,950,000 oz., Pb from 13,163,432 to 19,400,000 lbs. and Zn from 41,448,905 to 61,400,000 lbs. Cu production decreased from 65,476,375 to 63,700,000 lbs. AHE (15a)

Zinc Industry in 1934—Advance Summary. H. M. MEYER. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 333, Jan. 3, 1935, 2 pages. Production of primary Zn in 1934 (363,800 tons) increased 18% over 1933, following a gain of 48% in 1933. Apparent domestic consumption of primary Zn increased 8% (51% in 1933). AHE (15a)

American Iron and Steel Industry in 1934. B. E. V. LUTY. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, pages 91-92. Review. IIa (15a)

Recording and Evaluating Data on Material Economy in a Steel Plant (Aufschreibung und Auswertung der Betriebsbeobachtungen für die Stoffwirtschaft eines Hüttenwerkes). W. KALKHOF. *Stahl und Eisen*, Vol. 55, Jan. 17, 1935, pages 60-66. Accounting and statistical methods are described for keeping track of material consumption and losses as they go through the different processes. The effects of variables in the kind of steel and method of operation on material losses, are also indicated. SE (15a)

Metal Mining in Oregon, 1934—Advance Summary. F. W. HORTON & C. W. MERRILL. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 340, Jan. 15, 1935, 2 pages. Au output in Oregon in 1934 was about 32,200 oz., as compared with 20,240 oz. in 1933. Ag production was 58,000 oz., an increase of 38,140 oz. over 1933. Cu output was about 43,000 lbs. a gain of 31,547 lbs. over 1933. Pb production increased from 9,379 to 48,000 lbs. and Zn from 12,290 to 69,700 lbs. The total value was $1,172,000, an increase of 123%. AHE (15a)

Metal Mining in Nevada, 1934—Advance Summary. F. W. HORTON & C. W. MERRILL. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 339, Jan. 15, 1935, 3 pages. The 1934 output of Au in Nevada increased 103% to 146,700 oz.; the Ag output to 2,700,000 oz., 334% in value; Cu to 41,650,000 lbs., 83% in value; Pb to 21,600,000 lbs., 369% in value; Zn to 27,000,000 lbs., 116% in value; a total value of $12,163,565, an increase of 123%. AHE (15a)

Metal Mining in California, 1934—Advance Summary. F. W. HORTON & C. W. MERRILL. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 338, Jan. 15, 1935, 2 pages. Au output in California in 1934 increased to 701,000 oz. from 613,579 oz. in 1933; Ag increased from 402,591 to 789,000 oz., Pb increased from 761,156 to 850,000 lbs.; Zn increased from 290,214 to about 600,000 lbs.; Cu decreased from 990,380 to approximately 500,000 lbs.; the total value increased 68%. AHE (15a)

The British Steel and Iron Industry in 1934. J. P. HENDERSON. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, pages 72-73. Review and outlook. IIa (15a)

Metal Mining in South Dakota, 1934—Advance Summary. CHAS. W. HENDER- *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 327, Jan. 2, 1935, 1 page. In 1934, Wyoming produced Au 4900 oz., Ag 893 oz., and Cu 4000 lbs.; in 1933 the amts. were Au 2200 oz., Ag 260 oz. and Cu none. AHE (15a)

Metal Mining in Texas, 1934—Advance Summary. CHAS. W. HENDERSON. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 328, Jan. 3, 1935, 1 page. In 1934, Texas Mines produced Au 360 oz., Ag 816,623 oz., Cu 30,000 lbs. and Pb 570,000 lbs.; in 1933, output was Ag 160 oz., Cu 2000 lbs., and Pb 6000 lbs. AHE (15a)

Metal Mining in South Dakota, 1934.—Advance Summary. CHAS. W. HENDERSON. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 329, Jan. 3, 1935, 1 page. In 1934, South Dakota produced Au 481,727 oz. and Ag 100,376 oz. as compared with Au 512,404 oz. and Ag 125,417 oz. in 1933. AHE (15a)

Electricity in Electro-Metallurgy (Die Elektrizität in der Elektrometallurgie). E. REITLER. *Die Metallbörse*, Vol. 24, Aug. 4, 1934, page 986; Aug. 11, 1934, pages 1017-1018. Traces the development of electro-metallurgy alongside advancements in electrical engineering, and discusses wet and dry electro-metallurgical processes. Then gives full description of and presents plant data on (1) electrolytic refining of Cu, (2) Pb, (3) Zn and (4) Ni, and (5) electro-metallurgical production of Al and (6) Mg. EF (15a)

Economic Development of the Japanese Iron and Steel Industry (Japans Eisen-und Stahlindustrie in ihrer wirtschaftlichen Entwicklung). J. W. REICHERT. *Stahl und Eisen*, Vol. 54, Sept. 20, 1934, pages 979-986. The Japanese iron and steel industry has developed at a faster pace than that of any other country. Since 1913 Japan has multiplied its pig iron output 8 fold and its steel ingot output 12 fold. Japan now stands 7th in world iron and steel production. In 1933 it produced close to 3 million tons of rolled steel; exported 230,000 tons of iron and steel and imported 1,150,000 tons. SE (15a)

Metal Mining in New Mexico, 1934—Advance Summary. CHAS. W. HENDERSON. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 330, Jan. 3, 1935, 2 pages. In 1934, New Mexico mines produced Au 25,630 oz., Ag 1,058,232 oz., Cu 28,067,000 lbs., Pb 20,225,000 lbs. and Zn 52,808,000 lbs., a decrease for all but Cu. AHE (15a)

Metal Mining in Colorado, 1934—Advance Summary. CHAS. W. HENDERSON. *United States Bureau of Mines, Mineral Market Reports No. M. M. S.* 326, Dec. 31, 1934, 7 pages. In 1934, Colorado produced Au 317,214 oz., Ag 3,389,552 oz., Cu 11,040,000 lbs., Pb 8,296,000 lbs., and Zn 1,505,000 lbs., all substantial gains over 1933 except Zn. AHE (15a)

High Lights of the Industrial Development of the Soviet Union. GORDON FOX. *Iron Age*, Vol. 133, June 21, 1934, pages 31-33, 74-75. From a paper read before the joint meeting of the American Society of Mechanical Engineers and the Western Society of Engineers in Chicago. Deals with the natural resources of Soviet Russia and what has been accomplished through industrial standardization. VSP (15a)

Bauxite, Alumina and Aluminum Industries in France (l'industrie Francaise de la bauxite, de l'alumine et de l'aluminium). *Journal du Four Electrique*, Vol. 43, Sept. 1934, pages 324-326. Statistical. JDG (15a)

Housing Program Offers Wider Market for Steel. L. W. MOFFETT. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 108, 111. Large potential outlets for Fe and steel lie in the Federal Housing Administration's program. It is estimated by FHA that a total of $119,918,449 worth of repairs and modernization was created through Nov. 30, 1934. 192 Fe and steel and foundry companies have pledged their cooperation to the FHA. Metals used are Al, steel alloys, Ni alloys, etc. VSP (15a)

Sees Plant Obsolescence Creating Heavy Steel Demand. ARTHUR G. MCKEE. *Steel*, Vol. 96, Jan. 28, 1935, pages 10-12. Interview on obsolescence in the American iron and steel industry. Average age of plant equipment in the industry is close to 20 years. About 25% replacement of present plant equipment would be necessary to enable plants to run efficiently at present 100% rating. Probable cost of modernizing the industry would amount to $1,000,000,000-1,500,000,000 in the next 5 years. MS (15a)

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Canadian Steel Industry Makes Gain. *Steel*, Vol. 96, Jan. 7, 1935, page 222. Review of iron and steel industry during 1934. Tabulates production since 1923. MS (15a)

Belgium Finds Steel Trade Outlets Greatly Reduced. *Steel*, Vol. 96, Jan. 7, 1935, pages 221-222. Reviews conditions in the iron and steel industry during 1934. Gives statistics on average monthly production, imports, and exports for 1913, 1931-Oct. 1934, including those for Luxemburg. MS (15a)

Marked Rise in Germany's Steel Production and Sales. *Steel*, Vol. 96, Jan. 7, 1935, pages 219-220. Review of iron and steel industry during 1934. Tabulates statistics on average monthly production, imports, and exports for 1913, 1931-Oct. 1934. MS (15a)

Silver Market Dictionary. HERBERT M. BRATTER. Commodity Exchange, Inc., New York, 1933. Cloth, 6 x 9½ inches, 202 pages. Price $1.75.

This book is an invaluable guide to those interested in the silver market—particularly helpful in its full inclusion of so many of the foreign terms. It will clarify for the layman many puzzling bits of terminology encountered in dealings in the white metal, definitions for which are not generally found in the regular dictionaries.

It is evident that this book is the product of careful research work. While it is true that "Time Marches On" and even since its publication in 1933 there have been a few changes—such as the discontinuance of trading in silver on the New York Commodity Exchange, the new gold price basis and the Silver Purchase Act of 1934—the book fills a long-felt need. J. C. Travis (15a)-B-

Metal Statistics, 1935. Published by American Metal Market, New York, 1935. Cloth, 4 x 6½ inches, 560 pages. Price $2.00. This edition of "Metal Statistics" furnishes, in its usual compact and handy form, a record of production, consumption, imports, exports, stocks, price fluctuations and averages (monthly and annually), data on various brands, analyses, trade terms, custom duties, etc., applying to finished and semi-finished ferrous and non-ferrous metal products as well as raw materials. Richard Rimbach (15a)-B-

15b. Historical

Non-Ferrous Metals—Past and Future. ZAY JEFFRIES. *Iron Age*, Vol. 134, Nov. 8, 1934, pages 20-23, 77. From paper presented to Metropolitan Section of American Society of Mechanical Engineers. A review of current uses of non-ferrous metals as well as the individual properties which fit each for a specific purpose. Considers also the favorable factors in the non-ferrous metal industry of the future. VSP (15b)

Ten Years of German Welding Technique (Zehn Jahre deutscher Schweisstechnik). A. HILPERT & W. ADRIAN. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Feb. 16, 1935, pages 187-192. Development of welding methods during the last 10 years is reviewed and illustrated by examples of older welds and modern complicated joints. Ha (15b)

The Work of Walter Rosenhain. JOHN L. HAUGHTON. *Metal Industry*, London, Vol. 45, Sept. 7, 1934, pages 225-228. See *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 82. HBG (15b)

6 **The Iron Age of Dura Craftsmanship.** JOHN W. HIGGINS. *Iron Age*, Vol. 135, Jan. 10, 1935, pages 13-15, 75. Discusses the archaeological discovery of the Fine Arts Expedition of Yale. Relics in wrought Fe date back 1800 years. These relics were found on the site of Dura-Europas on the Euphrates river. Heretofore these relics were ascribed to the 8th century. Both the metal and craft technique as well as design of these specimens favor the Middle Ages. Describes the wrought Fe objects collected by the expedition. VSP (15b)

7 **Origin and Evolution of Ferro-Alloys in France (Origine et évolution en France des ferro-alliages).** M. LAMY. *Journal du Four Electrique*, Vol. 44, Jan. 1935, pages 10-15. Historical. JDG (15b)

The Primitive Use of Gold. T. A. RICKARD. *Bulletin of the Institution of Mining & Metallurgy* No. 361, Oct. 1934, pages 1-5; No. 362, Nov. 1934, pages 19-20. Discussion. See *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 82. AIME (15b)

The Primitive Smelting of Copper and Bronze. T. A. RICKARD. *Bulletin Institution of Mining & Metallurgy* No. 363, Dec. 1934, 26 pages. Historical. AIME (15b)

8 **The Earliest History of Chilled Cast Iron (Aus der frühesten Geschichte des Hartgusses).** E. SCHÜZ. *Giesserei*, Vol. 22, Jan. 18, 1935, pages 22-26. The first attempts to make chilled cast iron in Germany and subsequent history up to 1833 are described. Ha (15b)

American Wrought and Cast Iron of the Civil War Period. H. M. WILTEN & E. S. DIXON. *Metals & Alloys*, Vol. 6, Mar. 1935, pages 63-66. Study of material from a Civil War naval vessel exposed on a sand bar on Gulf coast since 1863 shows that corrosion resistance of cast and wrought iron produced in those days is comparable with that of the present time. WLC (15b)

9 **Expansion Program for 1934 Dominated by 4-High Mills.** *Steel*, Vol. 96, Jan. 7, 1935, pages 117-118, 258-259. Survey of equipment expansion, replacement, and improvement in American iron and steel plants during 1934. Outlines programs of construction completed or in process of completion by various companies. There were 6 blast-furnaces remodeled, 1 open-hearth furnace with annual capacity of 25,000 tons completed, 21 rolling-mills completed, and 15 rolling-mills building. MS (15a)

10 **Belgium-Luxemburg Leads in Per Capita Steel Consumption.** *Steel*, Vol. 96, Jan. 7, 1935, pages 140-141. In 1934, average per capita consumption was Belgium-Luxemburg, 477 lbs.; United States, 447 lbs.; Germany, 389 lbs.; Great Britain, 371 lbs.; France, 286 lbs.; Russia, 142 lbs.; Italy, 96 lbs.; and Japan, 53 lbs. MS (15a)

Exports at Peacetime High as Scrap Goes International. *Steel*, Vol. 96, Jan. 7, 1935, pages 129-130. Reviews status of iron and steel scrap exports. For 1934, total will be over 1,850,000 tons. MS (15a)

Current News Items

A Tool Steel Selector

The "Tool Steel Selector," for use in your tool room, is the title of a large chart, 30 in. by 20½ in. which has been published by the Carpenter Steel Co., Reading Pa. No little credit is due to F. R. Palmer, assistant to the president of the company, for its conception and application.

The Selector has been designed to provide the tool room with a more dependable, easier and safer method of selecting the proper tool steel for each job. It is claimed that this selector aids the tool maker in avoiding unnecessary hazards in his selections and guides him safely in his selection of better tools, "just as the compass aids the captain of a ship to avoid danger and helps him to steer a safe course into the right port." It is claimed that, although there are thousands of different kinds of tools practically all of them can be classified into nine groups and it is these nine groups which form the basis for what is designated the Carpenter Matched Diagram. The nine groups are represented by nine diamonds and when the type of tool steel a user is planning to make is listed in a certain diamond, the tool steel named in that diamond is the one which should best serve his purpose. There are many valuable details connected with the chart which only a careful study and examination will reveal.

The fifth Schoellkopf medal was recently publicly awarded to **F. A. Lidbury,** president, the **Oldbury Chemical Co.,** Niagara Falls, N. Y., "for his many contributions to the science of electrochemistry and for his activities as a chemist and executive in the service of the American chemical industry."

Myron **A. Coler** has been selected as the seventh **Weston Fellow** by the Weston Fellowship Committee of The Electro-chemical Society. He was graduated from Columbia in June as a chemical engineer and is now working toward his Ph.D

W. B. **Sullivan,** well-known in the development and manufacture of heat and corrosion resistant alloy castings, and organizer of the Michiana Products Corp., has joined the alloy department of **Lebanon Steel Foundry,** Lebanon, Pa. With a separate alloy foundry, completely equipped with Ajax electrothermic induction type melting furnaces, special heat-treating facilities, and a personnel with a thorough knowledge of foundry and metallurgical technique under the direction of Mr. Sullivan, the alloy casting trade may be assured of obtaining the same quality and service which has been identified with the alloy and carbon steel castings furnished by Lebanon Steel Foundry for the past 25 yr.

A. J. O'Leary has been appointed assistant to the general manager of sales at **Lukens Steel Co.,** Coatesville, Pa. Prior to joining the Lukens organization in 1916, he was with the Pennsylvania Railroad and the Alan Wood Steel Co. He spent five years in the mills and mill service departments at Lukens before he was transferred to the sales department, where he served since 1931 until his recent appointment.

Ekstrand & Tholand, Inc., importers of Swedish iron and steel specialties, high and low carbon wires, wire rope, tool steels, pig iron and sponge iron are now located at a new address, 441 Lexington Ave., New York, N. Y.

The **Lea Mfg. Co.,** Waterbury, Conn., specialists in the manufacture of buffing and polishing compounds, announces the addition of two research men to its technical staff: **George W. Muscio,** chemical engineer formerly with the Hanson Van Winkle Munning Co. and **Dr. Henry L. Kelner,** formerly with the Sterling Laboratories, New Haven, Conn. These men will devote most of their time to research work in connection with polishing, buffing and electroplating problems and to the development of new products. The Lea company has greatly enlarged its laboratory for this purpose and will be glad to cooperate with the trade on any of its problems.

Robert P. J. McCarty has been appointed sales engineer in the New England territory by the **S.K.F. Steels, Inc.** Mr. McCarty had previously been connected with the Ludlum Steel Co. for a number of years.

Foundrymen Contribute to European Meetings

Three members of the American Foundrymen's Association have been chosen to present papers on American practice before meetings of European foundry associations to be held this summer.

George Batty, technical director, Crucible Steel Castings Co., Lansdowne, Pa., and a director of A.F.A., is to present a paper entitled "Controlled Directional Solidification of Steel Castings before the June meeting of the Institute of British Foundrymen.

Dr. Harry A. Schwartz director of research, National Malleable & Steel Castings Co., Cleveland, is to present a paper before the September meeting of the Association Technique de Fonderie de Belgique, the Belgian technical foundry association. Dr. Schwartz's paper will present the commercial and technical possibilities of malleable cast iron. The Belgian Congress will be held in Liege,

For the October Congress of the French Technical Foundry Association, which will be held in Paris, the A.F.A. exchange paper will be presented by W. G. Reichert, metallurgist, Singer Mfg. Co., Elizabeth, N. J. Mr. Reichert's paper will deal with the "Present Status of Investigation and Control of Molding Sands."

Dr. John Chipman has joined the research staff of the **American Rolling Mill Co.,** Middletown, Ohio, as associate director of the research laboratories. He will be responsible for research activities in the field of melting and refining metals. For six years he was research engineer in the department of engineering research at the University of Michigan. Dr. Chipman was the recipient of the Howe Medal of the American Society for Metals in 1934, being awarded this distinction for his paper on "The Application of Thermodynamics to the Deoxidation of Liquid Steel." He was graduated from Sewanee in 1920 and received his M.S. degree at the University of Iowa in 1922 and his Ph.D. degree at the University of California in 1926.

The **Brown Instrument Co.,** Philadelphia, manufacturers of instruments and controls, and the **Minneapolis-Honeywell Regulator Co.,** Minneapolis, Minn., manufacturers of control systems and regulators, have opened a joint office at 303—the 101 Marietta Street Building, Atlanta, Ga., to serve the Southeast. **Wesley R. Moore,** for a number of years district manager of Brown Instrument Co., is manager in charge, with **Leon L. Kuempel,** sales engineer, **Charles A. Kitzinger,** service engineer, and **J. A. Crawley,** office manager. A Minneapolis-Honeywell stock will be carried, and complete sales and installation service maintained at this office for the complete lines of both companies.

T. A. Canty, Baltimore, Md., distributor of arc welding equipment and supplies manufactured by the **Lincoln Electric Co.,** Cleveland, has found it necessary due to substantially increased business, to move from its former location at 116 East Centre St., to much larger quarters at 1023 Cathedral St., the new location, a three story building in the heart of the machinery and automotive section of the city.

In addition to providing every assistance in arc welding problems, the company will maintain a complete stock of arc welding machines, electrodes and supplies for welding by the Lincoln company's latest improved shielded arc process. The most recent developments include the latest models of the well known "Shield Arc" welder and two new electrodes "Abrasoweld" for super hardness and "Toolweld" for making cutting edges on metal and wood-working tools.

Lee Wright has been appointed sales representative for Republic Steel Corp., with headquarters at 401 Atlas Building, Salt Lake City, Utah. Prior to his connection with Republic, Mr. Wright had been associated with Zion's Co-operative Mercantile Institution, Salt Lake City, since 1902. The appointment will enable Republic to serve more efficiently the Salt Lake City territory, which in the past has been handled through Republic's Denver Office.

MANUFACTURERS' LITERATURE

Houghto-Clean

Interesting booklet containing a brief outline describing the use of the Houghto-Clean series of cleaning materials for metal working plants. E. F. Houghton & Co., Philadelphia, Pa. (A 201)

Properties of OFHC Copper

An attractive booklet contains reprints of three papers relating to the above subject. United States Metals Refining Co., 420 Lexington Ave., New York, N. Y. (A 202)

Plating with Duozinc

Technical information on zinc-mercury plating is contained in this operating manual. The data cover in general all phases of Duozinc plating. R. & H. Chemicals Dept. of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (A 203)

High Temperature Bonding Mortars

A leaflet contains information concerning Thermolith, which has a chrome ore base, giving recommended applications and directions for using.

Published by the same firm: "Harwaco Bond" contains information on this mortar which has a diaspore base, and "Firebond" which discusses this mortar with a silica base. Harbison-Walker Refractories Co., 1801 Farmers Bank Bldg., Pittsburgh, Pa. (A 204)

A Wear-Resistant Steel

A new edition of this pamphlet has been issued, containing a detailed description of the steel and data covering tests made in both cast and wrought forms. Climax Molybdenum Company, 500 Fifth Ave., New York, N. Y. (A 205)

New Blast Cleaning Method

Bulletin No. S-77 gives interesting information on the new Sly "Master-Blast" Mill which cleans by the use of low pressure air. The W. W. Sly Manufacturing Co., 4700 Train Ave., Cleveland, O. (A 206)

New Method of Applying Bonderite

Spra-Bonderizing, claimed by the manufacturer to be a great forward step in one of the most advanced methods for stabilizing paint finishes on iron and steel, is the subject of a colorful leaflet. Parker Rust-Proof Co., 2177 E. Milwaukee Ave., Detroit, Mich. (A 207)

Equipment Designs for the Pickle House

The advantages to be obtained by the use of Monel Metal in pickling equipment are set forth in an attractive booklet which contains many illustrations of operating equipment and new designs. The International Nickel Co., Inc., 67 Wall St., New York, N. Y. (A 208)

Murex Electrodes

This colorful booklet, No. 2, contains technical data, including principles of design and operation, as well as physical properties and chemical analyses of deposited metals. Metal & Thermit Corp., 120 Broadway, New York, N. Y. (A 209)

Standard Burners and Burner Equipment

This illustrated leaflet, SC67, contains interesting information about the subject. A number of installations are pictured. Surface Combustion Corp., 2375 Dorr St., Toledo, O. (A 210)

Cold Drawn Steels

A leaflet entitled "Shorten That Distance Between the Steel and the Finished Part" contains the statement that these steels are related to lower costs either through increasing the speed and efficiency of production or through eliminating some of the operations necessary with more common types of cold drawn steels. Union Drawn Steel Co., Massillon, Ohio. (A 211)

Fusion Facts

This publication contains articles which will interest those connected with the welding industry. Stoody Company, Whittier, California. (A 212)

Meehanite Metal

Bulletin No. 4 contains data on how hard wear resisting properties can be obtained from Meehanite, applications, erosion resisting properties and comparative service tables. Illustrated. Meehanite Metal Corp., Pittsburgh, Pa. (A 213)

Machine Gas Cutting

An attractive and well-illustrated booklet tells how this has been made practicable, from both operating and economic standpoints, by the development of the Airco-D-B Camograph. A number of the almost limitless possibilities for its profitable use are pictured and described. Air Reduction Sales Company, 60 East 42d St., New York, N. Y. (A 214)

Steel Treating

"Steel Stamina" contains articles of interest to steel treaters. Attractively illustrated. Lindberg Steel Treating Co., 218-24 Union Park Court, Chicago, Ill. (A 215)

Surface Treatment and Painting of Dowmetal

A leaflet, supplement to Dowmetal Data Book, is devoted to the above subject. The following features are discussed: cleaning, chemical treatment, painting and assembly protection. The Dow Chemical Co., Midland, Mich.

Published by the same firm: "Dowmetal 'J'—Wrought Alloy," a data sheet giving technical information on this alloy. (A 216)

Textile Equipment

A colorful folder, ADV 146, lists several reasons for the superiority of Enduro Stainless Steel in textile equipment. The manufacturers claim that Enduro does not react with the dye stuff and has been successfully used in processes such as singeing, sizing, mercerizing, drying and finishing of cotton fabrics. Republic Steel Corp., Massillon, O. (A 217)

Combining Materials

A reprint of this article concerning the many uses of the combination of molded plastics and die castings, is offered by The New Jersey Zinc Co., 160 Front St., New York, N. Y. (A 218)

Aerocase for Case Hardening and Heat Treating Steel

A colorful booklet is devoted to this subject. "Aerocase" consists of a molten bath which serves as a heating medium, and a case hardening compound. Information on equipment, applications and method and cost of operation is included. American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y. (A 219)

Centrifugal Castings

Engineering Data Sheet No. 16 gives useful information on the above subject. Ampco Metal, Inc., Milwaukee, Wis. (A 220)

Gordon Thermocouple Heat

A leaflet devoted to this subject, describes its advantages and economies. Claud S. Gordon Co., Inc., 708-714 West Madison St., Chicago, Ill. (A 221)

Spectrometers and Accessories

Bulletin 133 describes and illustrates several different models of spectrometers which the manufacturers claim are rugged and accurate. Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill. (A 222)

Z-Metals

An attractive bulletin contains quite detailed information on the physical characteristics of these metals, tables of average comparative physical properties and typical specifications which Z-Metals are produced to meet. Photomicrographs and illustrations are included. Arcade Malleable Iron Co., Worcester, Mass. (A 223)

Aluminum De-Gaser

This new method, it is stated by the manufacturer, is not dangerous to use and eliminates pinholes, removes gases present in metal or alloy and improves the physical properties. Directions for use are included. Foundry Services, Inc., 107 East 41st St., New York, N. Y.

Published by the same firm: "Coveral"—which is described in this leaflet as the scientific "blanket" for aluminum castings in sand or dies. (A 224)

Automatic DI Oil Burner

Bulletin No. 23 describes this burner in which all of the operative and control requirements of an oil burning operation have been assembled into a single unit. Illustrated. R-S Products Corporation, Germantown Ave. at Wayne Junction, Philadelphia, Pa. (A 225)

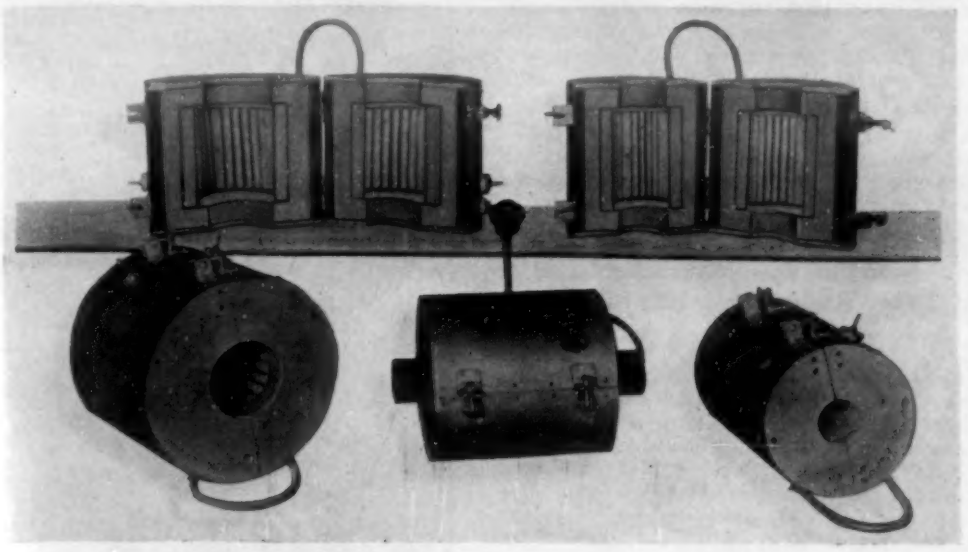
Multigrip Floor Plate

This floor plate was designed to provide maximum skid resistance regardless of the way the plate is laid or whether wet or dry. Illinois Steel Company, 208 S. La Salle St., Chicago, Ill. (A 226)

New Equipment and Materials

Electric Stress Relieving Heaters

A little more than a year ago, H. O. Swoboda, Inc., Pittsburgh, developed "Falcon" electric heaters for local stress relieving of longitudinal and circumferential welded seams in large pipes, penstocks, pressure vessels, etc. Since that time the company has developed another type of heater which has been successfully used also for simultaneous stress relieving of one circumferential and four longitudinal seams in penstocks 20 ft. in diameter, 20 ft. in length, 1⅝ in. thick.



In addition to the above the company now announces the development of "Falcon" cylindrical type units for local stress relieving of welded seams in high pressure piping, etc., and "Falcon" nozzle heaters for stress relieving nozzle welds.

The cylindrical type units as illustrated consist of two semi-circular heating units and include heat insulation, refractory plates, nickel-chromium heating elements and plug type terminals with plugs for portable cable attachment. The refractories are backed by solid heat insulation around the sides and similar insulation is provided on each end. The heater, together with its insulation, is assembled in sheet steel casing having high temperature insulating board ends. Hinges are provided so that the heater can be opened up for mounting around the pipe joints. Wing bolts are supplied for keeping the heater tightly clamped around the pipe while stress relieving. A thermocouple opening is provided in the side of the heater.

One size of unit can be used for several pipe sizes. For example, a heater for stress relieving 4 in. dia. pipe can be used for stress relieving 1½, 2 and 3 in. pipe as well. This is accomplished by inserting refractory bushings into the ends of the heater for each of the smaller sizes so that they will fit snugly around each pipe size. In addition, the end heat insulation is removable so that the heaters can be used for stress relieving the welds of pipe bends.

The cylindrical type units are supplied for stress relieving pipes up to 8 in. in diameter. For larger pipe sizes, the heaters are built in a form strapping around the pipe of segments (three or more) for strapping around the pipe to accomplish the desired stress relieving.

"Falcon" nozzle heaters, consist of two sections each arranged for clamping around the nozzle and pipe. The construction is similar to the cylindrical type units. "Falcon" stress relieving heaters are supplied for operating directly on various standard voltages, such as 110, 220 or 440 volts. They can also be furnished for operation from welding machine generators if desired. For control of the temperature during stress relieving operations, manual or automatic control equipment can be used.

Goodrich Vulcalock Valves

A rubber-lined valve of simple, rugged design and reasonable cost, suitable for handling corrosive and abrasive fluids under conditions of fairly high pressure, pulsating pressures, throttling or suction, is announced by the B. T. Goodrich Co., Akron, Ohio. "Vulcalock Valves" may be lined with any of the standard Goodrich Acidseal compounds, hard or soft, depending upon conditions of service. The action of the valve does not depend upon a flexible diaphragm. The resilient, rounded disc which snaps over a circular plate at lower end of stem provides an absolute seal when brought into contact with the molded rubber-covered seat rings. Both disc and seat ring are simple, inexpensive, easily replaceable parts.

Nearly straight line of flow renders the Vulcalock Valve especially adaptable to fairly high pressure work and abrasive service. The molded seat ring can be removed simply by taking off the body bolts. The Acidseal lining of the Vulcalock valve is bonded to the metal parts with practically integral adhesion by the patented Goodrich Vulcalock process. Corrosive or abrasive materials handled come in contact only with rubber especially designed to resist their deteriorating actions.

"Alupak"—Composite Metal Sheets

Alupak sheets are constructed of alternate layers of thin sheet aluminum and fine wire mesh. An elastic compound binds the various sheets together into one flexible piece, forming a gasket which, it is claimed, will hold even on warped and super-heated surfaces since the gasket actually swells when subjected to heat. This expansion forces a perfect seal on all parts of the flanged surface and fills in all warped or uneven spots.

Another Wrought Magnesium Alloy

A wrought "Dowmetal" magnesium alloy, termed "Dowmetal J," is called attention to by the Dow Chemical Co., Midland, Mich. It is included with the wrought alloys because of its higher elongation, fatigue endurance limit and corrosion resistance. Its chemical composition is: Al 6 to 7; Mn 0.20 min.; Zn 0.5 to 1 per cent with Mg the remainder. Its mechanical properties are: T.S. 41,000 to 45,000 lb. per sq. in.; Y. S. 28,000 to 33,000 lb. per sq. in.; elongation 15 to 20 per cent; Rockwell (E) 61 to 70; Brinell 51 to 58 and fatigue endurance limit 16,000 to 19,000 lb. per sq. in. Other properties are: Sp. gr. (75° F.) 1.80; weight lb. per cu. in., 0.065; melting point 115.5 deg. F., and coefficient of thermal expansion per deg. F. (65 to 750° F.) 0.000016. It is obtainable in nearly all extruded shapes and as press forgings. It responds to the chrome-pickle treatment and may be painted subsequently, the same as other Dowmetal alloys.

A Greaseless Compound

The Lea Manufacturing Co., Waterbury, Conn., announces the development of a new Grade "L" Lea Compound (a patented greaseless compound) to meet the requests for a fast-cutting Lea compound containing a coarse, sharp abrasive. Grade "L" Lea Compound is greaseless and is used for replacing set up wheels in the fine numbers and for fast cutting-down, previous to buffing or coloring. It took considerable time to develop this new compound because of the great difficulty encountered in making the very coarse, sharp abrasive adhere properly to the wheel and give efficient service. This difficulty was overcome by Lea research engineers through the development of a new binder.

A Special Mask

A "Healthguard Mask" has been put on the market by the Chicago Eye Shield Co., 2300 Warren Boulevard, Chicago. It is rated at 99 per cent plus efficient and, while primarily designed for sand blasting, it is claimed applicable to any operation in which protection to the nose, mouth and respiratory organs is necessary, as in foundries, steel mills, transport companies, tank car makers, metallizing operations and so on.

Time Control Unit Adjustable to Job-Requirements

In the new series 1274-5-6 Time Controls, of the Automatic Temperature Control Co., Philadelphia, Pa., designed to repeat one or two operations or processes as often as desired, provision has been made for exceedingly flexible choice of periods during which the controlled actions take place. The time controls in this series will handle a repetitive action or operation requiring a definite time period or cycle with either the same or different time

period between successive time cycles. The time cycle, and also the interval between successive cycles, is infinitely adjustable with an accuracy of setting to within a split scale division of the respective dial ranges selected. Parts have been so grouped on chassis that adjustment is simple. Jack connections permit removal of parts without disturbing wiring. Settings remain accurate despite vibration. Special contact-metal transmits current even when oxidized. They are available in 110 v. a. c. or 220 v. a. c. if especially ordered.

All Electric Machine Tool

The first completely electrified planer promises quicker machining, and reduced spoilage of work and machine damage due to inadvertent operation, according to engineers of the William Sellers and Westinghouse companies who designed it. A clever electrical "measuring-relay" rids the machine of ratchet boxes, cranks, bevel gears, rods, levers and the like. Simplicity is obtained by use for individual motors for each head, platen, rail elevating, clamp and lubricating drive. The planer boasts many technical features —a unique main driving motor with 10:1 speed range from constant d.c. voltage supply (rated 100 hp. at 40 ft. per min.. and above) gives cutting speed of 20 to 200 f.p.m.; magnetic clutches interconnect the motions, and a "tarry control" permits planing into a pocket at high speed without overrun in feeding. The net result is a machine tool that approaches the ultimate in efficiency, safety, convenience of operation and appearance.

All operations for the 60 in. x 60 in. x 30 ft. planer, including control of the seven motors, tool lifters, magnetic clutches, clamp, feed settings, and the like are concentrated here. Each button or switch is "geographically" located to indicate direction in which the head moves. After the job is set up, complete control of normal machining operations is centralized in the movable pendant station.

Another Low-Alloy Steel

A new alloy steel has just been announced by the Youngstown Sheet & Tube Co. This new product, known as "Yoloy," is a nickel-copper alloy steel, having an exceptional resistance to corrosion, high tensile strength combined with high ductility, workability and weldability. It is produced in sheets, strips, plates, bars, shapes, wire and seamless pipe.

A Cu-Ni-Mo Low Alloy Steel

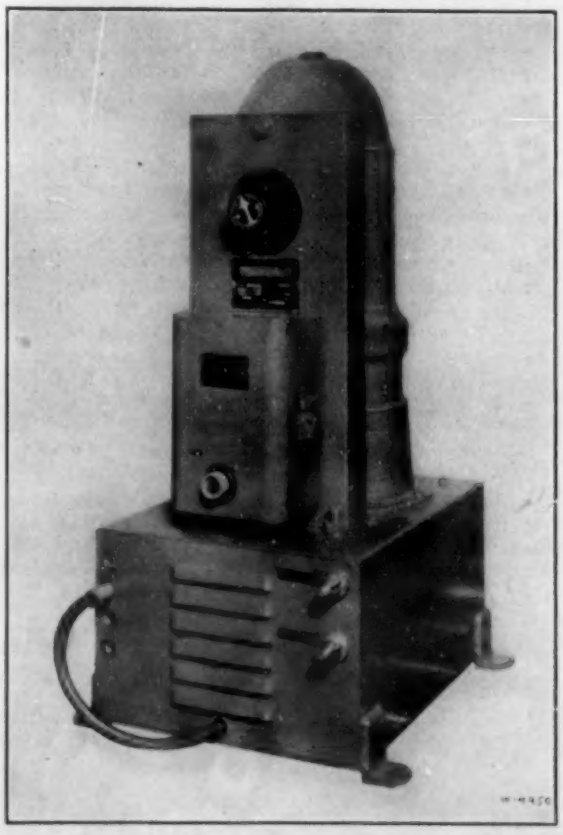
Some months ago announcement was made that the Republic Steel Corp., Youngstown, Ohio, had developed a new low-alloy, high-tensile steel. It has been given the trade name "Double Strength Steel." Recent publicity reveals that this steel is available in two grades: No. 1 and No. 1-A. The No. 1 steel analyses: C 0.12 (max.), Mn 0.50 to 1, Cu 0.50 to 1.50, Ni 0.40 to 0.80 and Mo 0.20 (max.) per cent. No. 1-A differs from this only in carbon which is 0.3 (max.) per cent. The tensile strength of the two steels, as normalized sheet, strip and plates, are respectively, 75,000 lb. per sq. in. min. and 90,000 lb. per sq. in. min. with the yield point 60,000 and 70,000 lb. per sq. in., and the elongation in 2 in., 25 and 18 per cent min.

This steel is claimed to offer a combination of high strength, ductility and resistance to atmospheric corrosion. It is pointed to as the result of several years of special research.

New Type Welder for Use on Light Materials

A new, small, low priced motor generator type of arc welding machine is announced by the Lincoln Electric Co., Cleveland. This machine brings the many advantages of arc welding to automobile repair shops, sheet metal and fabricating shops and others called upon to weld thin gauge materials. Known as the SA-100, this new unit opens up an entirely new field of application for arc welding, since it delivers as low as 30 amperes at the arc without use of auxiliary devices.

The new type is motor driven, with a current range of 30 to 125 amp. The generator is of single operator variable voltage type with 100 amp. NEMA rating. Easy welding is assured by



patented dual control which provides independent adjustment of open circuit voltage and welding current.

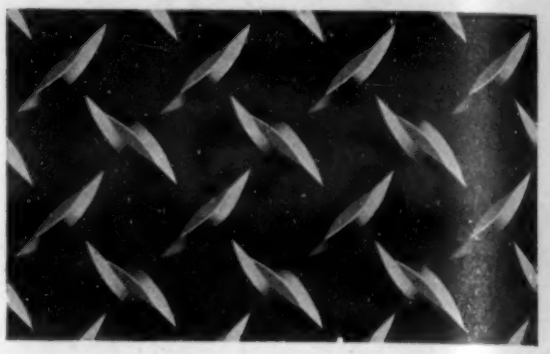
The new welder is normally 220 or 440 volts and can be furnished for 110 or 550 volts, 3 or 2-phase, 60 and 50 cycles as desired. Connections are readily available for reconnecting from 220 to 440 volts, or vice versa. It is 20 in. long, 16 in. wide and 40 in. high. It requires less than 2¼ sq. ft. of floor space. The price of the welder completely wired ready for operation is only $275 for 60 cycle power and $295 for 50 cycle.

Automobile repair shops, which in the past have had to resort to preheating and other methods of repairing which have required similarly inefficient equipment, can now obtain the faster welding speeds, higher quality welds and lower welding costs made possible by the electric arc.

Sheet metal shops and others, called upon to weld thin gauge materials, are enabled by the SA-100 to produce in thin sheets, plates and shapes the same high quality welds regularly obtained in heavier materials with the shielded arc process of welding.

"A.W." Super-Diamond Pattern Floor Plate

A scientifically designed floor plate has recently been introduced by a large manufacturer of rolled steel floor plates. The "Super-Diamond Pattern" is the latest of five types manufactured by the Alan Wood Steel Co., Conshohocken, Pa., and embodies the universally approved "A.W." oval shape raised projection spaced in a manner to



produce the maximum under-foot safety under all traffic conditions. It offers non-slip protection in all directions.

In addition to the usual uses such as stair treads, walkways, etc., this product serves as steel armor for new or worn out flooring of various types. It is available in a wide range of sizes, in thickness from 1/16 up to 1in., inclusive.

High Hardness Developed in Non-Corrosive Castings

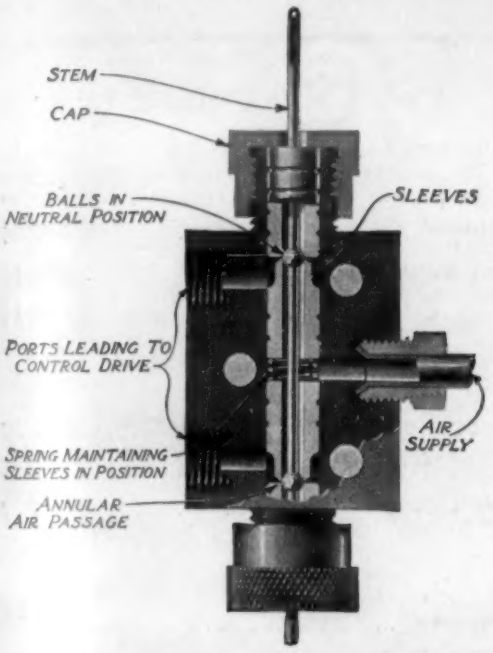
A new development in corrosion-resistant castings has been announced by the Bayonne foundry of the International Nickel Co. This is the production of a new material to meet special purposes.

Known as S Monel, this material is somewhat similar in analysis to regular Monel metal, the essential difference being its silicon content, which is raised to a maximum of 3.75 per cent. In properties it has a higher hardness than the regular grade of Monel metal, and a greater resistance to wear and erosion, particularly steam erosion. Of outstanding importance is the fact that it is non-galling, especially at high temperatures. The as cast material can be machined without difficulty if the hardness is held to 325 Brinell by limiting the silicon to 3 per cent. The harder grades must be softened for machining and later rehardened by heat treatment. Its unique physical properties are indicated by the following: Tensile, 100,000 to 120,000 lb. per sq. in.; yield point, 90,000 to 110,000 lb. per sq. in.; elongation in 2 in., 2 to 5 per cent.; reduction of area, 2 to 5 per cent, and Brinell, 275 to 350.

Another grade of Monel metal, developed coincidentally, has an intermediate hardness of about 225 to 250 Brinell. Its chief advantage is a higher ductility than the S type though it is not as outstanding in antigalling qualities. Its silicon content is approximately 2.50 per cent.

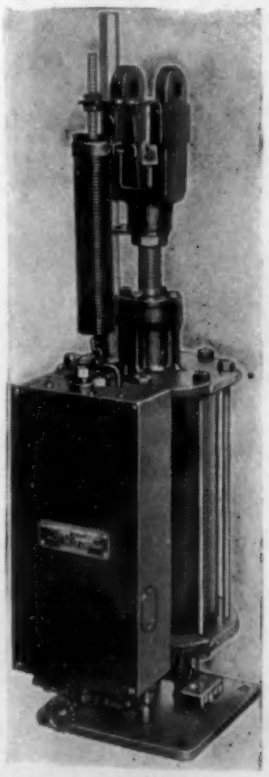
New Control to Insure Combustion Economy

A new air-operated combustion control, which automatically operates boilers to maintain steam pressure, furnace draft and maximum combustion economy has been developed by Bailey Meter Co. of Cleveland. This new system is claimed to greatly simplify central station economy methods and places them within reach of small industrial boiler plants, thereby making it possible for them to operate boilers



economically and safely for long periods of time, reducing outage and maintenance.

To accomplish this, the demand for steam is measured by variations in steam pressure and the rate of combustion is varied accordingly by the simultaneous control of fuel and air. This simultaneous control alone, however, does not insure the highest combustion economy since the relationship



between fan speed or damper position and air supply is not at all consistent and since stoker speed, feeder speed and oil or gas valve position does not hold a definite relation to the fuel supply. In order to overcome this difficulty, the new Bailey control system utilizes the steam flow—air flow relation of the Bailey boiler meter to readjust fuel or air supply so as to continuously maintain maximum combustion economy.

The control system is based upon the accurate measurement of all factors involved by standard Bailey recorders in which are incorporated frictionless free floating air pilot valves. As will be noted from the illustrations, these pilot valves are constructed so that they in no way decrease the accuracy or limit the operating ranges of the devices by which they are actuated.

Air is admitted at constant pressure to the space between the two balls. Since the balls are of equal size, this results in a perfectly balanced valve. Being of slightly smaller diameter than the pilot valve sleeve, a small quantity of air escapes which tends to prevent actual contact between the balls and the sleeve and acts as an effective lubricant.

The pilot valve shown is used for operating control drives of the type illustrated in the second illustration. Two outlets are connected to the control drive cylinder so that when the pilot valve is in a neutral position, as illustrated, the air pressure supplied to each side of the piston produces equal opposing forces and, therefore, the piston remains stationary. Should the pilot be moved slightly in either direction, increased air pressure would be admitted through one port to one side of the piston and air would be exhausted from the other side through one other port. Complete flexibility of the control system is provided by selector valves on the master and individual boiler panels.

The "Trigonograph"—A Rapid Calculator

A new rapid numerical calculator and complete trigonometric function table on a single page has been made public by the Chemical Rubber Publishing Co., Cleveland. The calculator, or "Trigonograph," is a simplified and unique means for solving trigonometric problems, available for engineers, teachers and students. Among its several uses are the solving of right and oblique triangles, multiplying, dividing and so on.

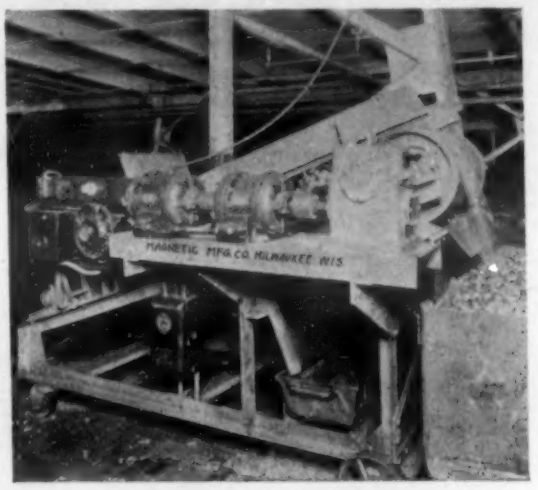
New Anodes of Zinc, Aluminum and Mercury

The Hanson-VanWinkle-Munning Co., Matawan, N. J., announces the development of a new anode named "ZAM" (zinc, aluminum, mercury). This new anode is not attacked by either acid or cyanide solutions until the current is applied. This makes it possible to have an anode free from sludge, and which, therefore, can be completely used in a zinc solution. No sludge will be found in the bottom of a tank regardless of how long the anodes are used. Therefore, practically no increase of voltage will be required at any time, either at the start of or during the plating, whether the run is short or very long. This permits setting the rheostat at a required point with complete assurance that the desired amount of zinc desired will be deposited in the given time. When ordinary zinc is used, a higher voltage is necessary to obtain the required current density, as the anode coats over with decomposed zinc.

ZAM anodes can be used in cadmium solutions and will convert such solution into zinc solutions without any trouble. The plating operations can be carried on without interruption until the cadmium solution is completely converted to a zinc solution. Then the highest efficiency of zinc deposition from a cyanide solution can be obtained. These anodes are being used with success by prominent wire and cable, leading automobile, hardware, and automotive accessory manufacturers.

Magnetic Separator Machines

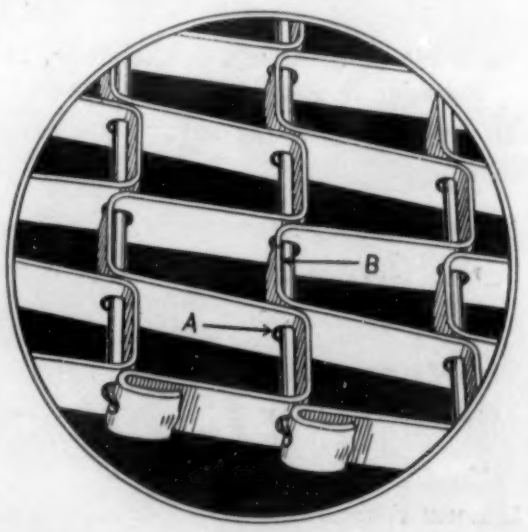
The Magnetic Mfg. Co., Milwaukee, Wis., offers magnetic separation equipment under the designation, "Chase Metal Machines," one of these units being shown by the accompanying illustrations. These machines are claimed to have much greater capacity than



similar machines and to produce a superior concentrate. These machines are equipped with motor, generator and reducer, all mounted in a separator, as well as with a special panel with rheostat, motor starting switch, pilot light and bell ring transformer.

New Design for Steel Mesh Conveyor Belts

The Acme Steel Co., Chicago, manufacturers of open mesh, steel conveyor belts for many years, has recently announced an improvement in construction of these belts which appears to be minor, but which really is of great importance from a service and maintenance view-point. "Acme Belts" are especially adapted for conveying products through drying ovens, for sorting



and assembling departments, and for many other operations. The open mesh allows free circulation of air, heat, water, steam, making it an ideal conveyor for products that must be washed, cooled, or dried. The belts are manufactured of cold rolled strip steel, electro-galvanized to resist rust, or of Acme stainless steel.

Acme belts are composed of formed spindles of flat steel connected by pivot rods. Formerly, these rods were strung through round holes, and the edge of the hole was the only bearing for the rod. To reduce wear on these rods, the holes are now elongated to a point where the entire flat surface of the U-shaped section is utilized as a bearing as illustrated. This simple change has materially increased the serviceable life of the belts, and has also increased the flexibility and smoothness of operation.

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